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Effect of Partial Replacements of Soda by Lithia in Opal and Alabaster Glass*

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Lithia in Opal and Alabaster Glass

● PAST WORK IN OUR LABORATORY shows that introduction of lithia into soda-lime glass reduces melting and fining time, increases fluidity, lowers thermal expansion, and slightly increases the refractive index. Recent studies also show similar benefits when part of the soda is molecularly replaced by lithia in commercial opal and alabaster glasses.

Opal, opalescent, and alabaster glasses belong to a group of glasses called *milk glasses*. Their internal structures scatter incident light and, as a result, the glasses appear white and are characterized by translucency without transparency. Although the terms are often used interchangeably, the glasses are different. According to Blau[1], an opal glass is one which does not directly transmit light, and the outline of a lighted lamp filament cannot be detected through normal thicknesses of such glass.

If the thickness of the glass is sufficiently reduced, however, the outline of the filament is sharply defined as an image of reddish color. An opalescent glass appears white in reflected light, and also shows the reddish outline of the filament through normal thicknesses. In either normal or reduced thicknesses alabaster glasses show the filament outline without affecting the color.

The characteristic light-scattering properties of milk glasses are due to the many tiny inclusions they contain. The degree of opacity depends on:

1. Number of inclusions
2. Size of inclusions
3. Refractive indices of inclusions and the glass.

The inclusions may be gases (minute bubbles), amorphous solids (immiscible glasses), or small crystals. The size of these inclusions in opal glass ranges from about 0.4 to 0.7 microns in diameter and number from 10^{10} to 10^{14} per cubic centimeter. In general, alabaster glasses contain inclusions of larger diameter and lower numbers per unit volume.

Experimental Work

An opal and a zinc alabaster glass were chosen as base glasses for studying the effects of molecularly replacing part of the soda by lithia. In each glass, two replacements were made which represent approximately 0.25 per cent and 0.50 per cent Li_2O by weight. Original batches and compositions, and the lithia modifications, are shown in

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Table I.

Melting temperatures varied with compositions and ranged from 2220° F to 2300° F. All glasses melted easily and duplicate melts produced glass of consistent quality and appearance.

Commercial grade raw materials were used to make 1½ lb. batches of glass, melted in fireclay crucibles. Each base glass and its lithia modifications were simultaneously melted in an electric furnace heated by silicon carbide resistance elements. After the batches were completely in solution and appeared seedfree, bars, ½ in. x ½ in. x 6 in., and discs, 2 in. in diameter and ¾ in. thick were poured and annealed.

Thermal expansion of the opal glass was measured in a fused silica dilatometer. Coefficient of linear expansion was calculated for the range 100-300° C.

A Hunter multipurpose reflectometer was used for reflectance measurements. Three ground and polished discs of each glass were prepared in thicknesses of approximately 0.120 in., 0.200 in., and 0.600 in.

Reflectance measurements were made on each disc using green, blue, and amber illumination respectively. A black background was used behind each disc to minimize effects from stray light and to absorb the transmitted light component. Data thus obtained were used to calculate the trilinear coordinates of each glass. (Trilinear coordinates are the amounts of the three primary color stimuli expressed as fractions of their total.)

Green reflectance measurements were made on combined thicknesses of different discs of the same glass covering a range from 0.120 in. to 0.970 in. Oil, with an index of refraction similar to that of the glass, was used as an adhesive to hold the discs together and to provide optical continuity. Reflectivity (reflectance at a thickness so great that additional thickness does not change reflectance) was located by these measurements.

Using reflectance and reflectivity data with a diagram[2] prepared by the National Bureau of Standards from formulas of Kubelka and Munk, opacity and coefficient of scatter were also determined. The former is the ratio of reflectance when applied over a black backing to that when applied over a backing having a reflectance of at least 80 per cent.

The latter is the rate of increase of reflectance, with increase of thickness at nearly zero thickness over a black backing. Opacity also varies with sample thickness.

Experimental Results

Replacement of 1.0 wt. per cent Na_2O by 0.48 wt. per cent of Li_2O caused reductions of 8.4 per cent and 10.5 per cent in melting time and 23.0 per cent and 18.2 per cent fining time of the zinc alabaster and opal glasses respectively. Smaller reductions in these properties were observed when 0.5 wt. per cent Na_2O was replaced by 0.24 wt. per cent Li_2O.

Thermal expansion determinations showed that lithia-for-soda replacements lowered the expansion by 5.7 per cent in both cases. Data for expansion, melting, and fining are contained in Table II, while Fig. 1 shows thermal expansion curves for the base opal glass and its lithia modifications. Trilinear color measurements show that lithia-for-soda replacements produce slightly whiter opal glass and change the white color of zinc alabaster glass from slightly "green-yellow" to "green." The trilinear coordinates of these color changes are shown in Fig. 2. Reflectance data from which the coordinates were determined and the formulas used for the calculations appear in Table III.

Figs. 3 and 4 show that molecularly replacing small increments of soda by lithia slightly increases the transmission (lowers the reflectance). These data also appear in Tables IV and V.

Molecular replacement of soda by lithia slightly lowers the opacity of both base glasses. The coefficient of scatter of the opal glass is about 25.0 per cent lower when part of the soda is replaced by lithia. No significant effect on this property was observed in the zinc alabaster glass

FIG. 1. Effect of Lithia on thermal expansion of opal glasses.

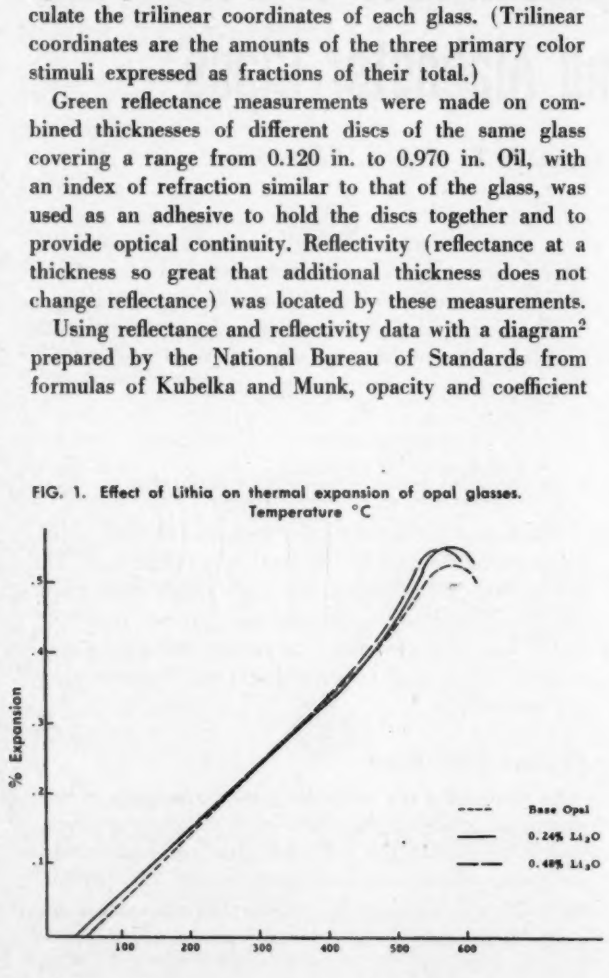
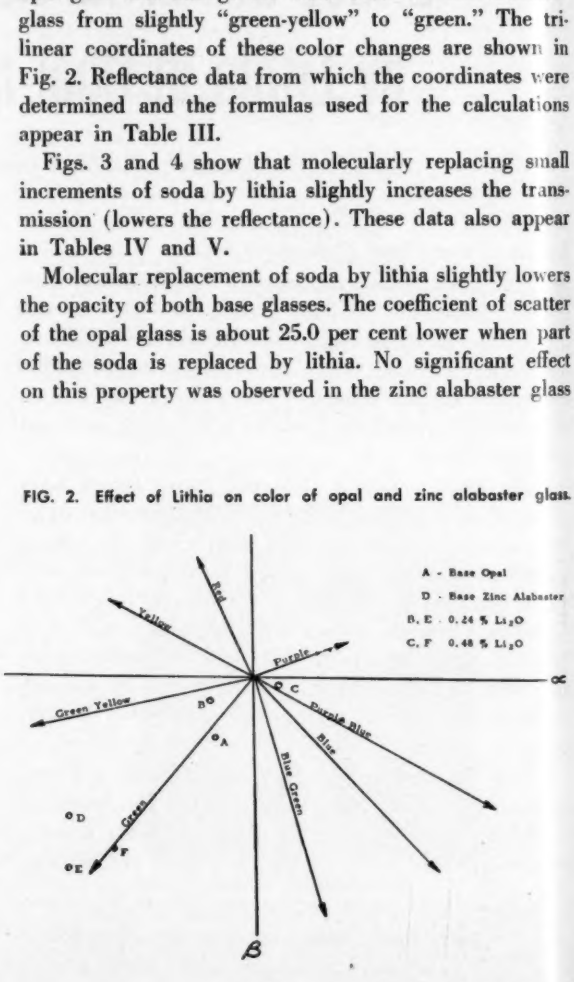


FIG. 2. Effect of Lithia on color of opal and zinc alabaster glass.



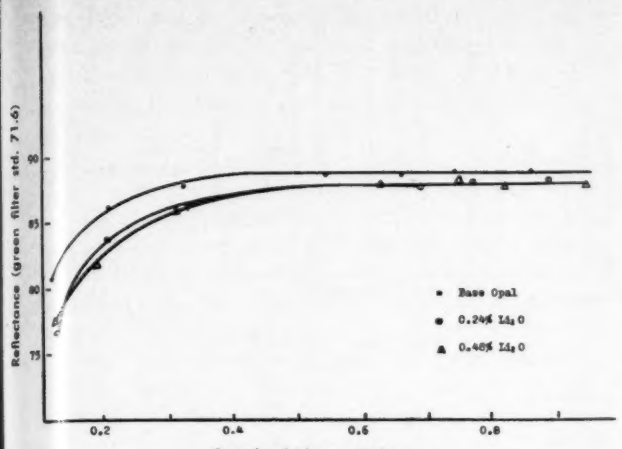


FIG. 3. Effect of Lithia on reflectance of opal glass.

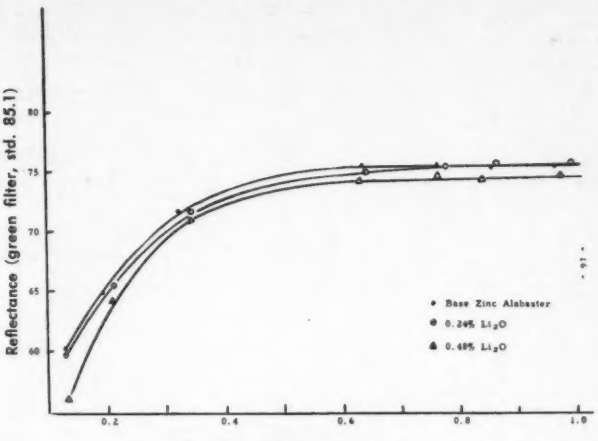


FIG. 4. Effect of Lithia on reflectance of zinc alabaster glass.

when lithia-for-soda replacements were made. These results appear graphically in Fig. 5 and are shown in Table VI.

Conclusions

The faster melting lithia glasses should permit greater throughput at no increase in capital or overhead costs.

(*Continued on page* 292)

Table I

ORIGINAL BATCHES AND CALCULATED OXIDE COMPOSITIONS WITH LITHIA MODIFICATIONS.

	Opal			Zinc Alabaster		
Raw Material	A	B	C	D	E	F
Sand	624	624	624	500	500	500
Soda Ash	225	215	205	75	67	59
Feldspar	234	234	234	200	200	200
Fluorspar	75	75	75	80	80	80
Sodium Silicofluoride	75	75	75	17.5	17.5	17.5
Potassium Nitrate	4.5	4.5	4.5	—	—	—
Arsenic Trioxide	1.08	1.08	1.08	2.5	2.5	2.5
Lithium Carbonate	—	7.0	14.0	—	5.5	11.0
Niter	—	—	—	37.5	37.5	37.5
Alumina	—	—	—	32.7	32.7	32.7
Zinc Oxide	—	—	—	95.0	95.0	95.0
Anhydrous Borax	—	—	—	59.4	59.4	59.4
Salt	—	—	—	5.0	5.0	5.0

	Calculated Composition (wt. %)					
Oxide						
SiO_2	69.1	69.3	69.5	60.1	60.3	60.4
Al_2O_3	3.56	3.57	3.58	6.40	6.41	6.43
B_2O_3	—	—	—	3.86	3.87	3.88
K_2O	2.35	2.36	2.37	2.03	2.03	2.04
Li_2O	—	0.24	0.48	—	0.24	0.48
Na_2O	13.8	13.3	12.8	8.46	7.96	7.46
CaO	4.63	4.64	4.65	5.39	5.40	5.42
ZnO	—	—	—	8.92	8.94	8.97
F_2	6.49	6.51	6.52	4.52	4.53	4.54
As_2O_5	0.11	0.11	0.11	0.27	0.27	0.27

Table II

PROPERTIES OF GLASSES

Composition	Temperature	Melting Time	Fining Time	Coefficient of Thermal Expansion
A	2220°F	190 min.	55 min.	9.60 x 10^{-6}
B	"	180 "	50 "	9.05 x 10^{-6}
C	"	170 "	45 "	9.05 x 10^{-6}
D	2300°F	240 "	65 "	.....
E	"	225 "	60 "	.....
F	"	220 "	50 "	.....

Table III

REFLECTANCE DATA FOR CALCULATION OF TRILINEAR COORDINATES †

Composition	Sample Thickness	Reflectance of Standard	Average Reflectance of Sample Green*	Blue*	Amber*
A	0.117 in.	71.6	80.8	81.6	80.3
B	0.129 in.	"	76.9	76.9	76.1
C	0.124 in.	"	77.6	78.7	77.0
A	0.205 in.	"	86.1	86.1	85.4
B	0.207 in.	"	83.7	83.5	83.7
C	0.193 in.	"	81.9	82.1	81.4
D	0.129 in.	52.9	59.0	60.8	58.2
E	0.129 in.	"	59.8	62.1	58.9
F	0.132 in.	"	55.4	57.4	54.9
D	0.195 in.	"	64.1	64.9	63.5
E	0.215 in.	"	64.2	64.7	63.6
F	0.210 in.	"	63.6	64.3	63.2

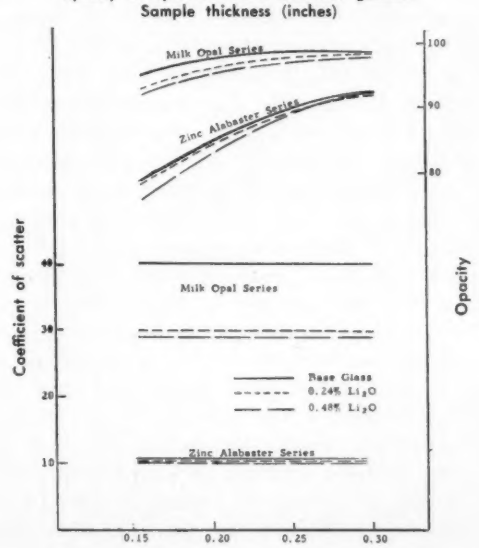
* Filter Color

† Trilinear coordinates were obtained by using above data (interpolated to a thickness of 0.165 in.) in following formulae:

$$\alpha = \frac{\text{Amber—Green}}{\text{Blue} + \text{Amber} + 2\ \text{Green}}$$

$$\beta = \frac{0.4\ (\text{Green—Blue})}{\text{Blue} + \text{Amber} + 2\ \text{Green}}$$

FIG. 5. Effect of Lithia and sample thickness on cofficient of scatter and opacity in opal and zinc alabaster glasses.



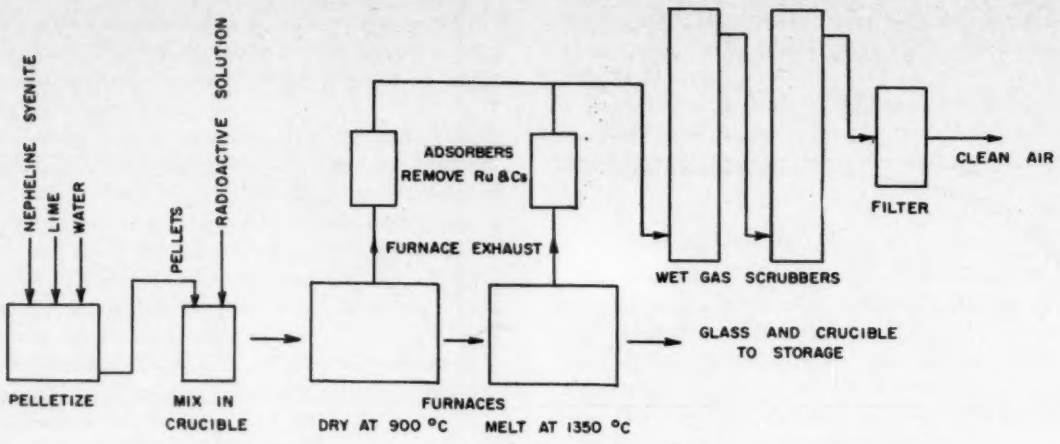


FIG. 1.

Incorporation of fission products into glass. Flow diagram.

GLASS for Disposing of Fission Products

by L. C. Watson, CHEMICAL ENGINEERING BRANCH, ATOMIC ENERGY OF CANADA LIMITED, CHALK RIVER, ONT.

Introduction

● ONE OF THE IMPORTANT CONSEQUENCES of developing a nuclear-power industry is that radioactive products accumulate. These result from the fission of the isotopes of uranium and plutonium used as fuel in the power-producing reactors. The weight of fission products produced is small by industrial standards, amounting to only one gram per thermal megawatt-day of reactor operation. However, the limits placed on the presence of the radioactive fission products in materials from which they can be ingested by humans are extremely low.

Strontium-90, for example, amounts to about 2.3 weight per cent of the fission products formed in the reactor. Because of its tendency to accumulate in bone, its relatively long half-life of 28.8 years and the rather high energy of beta-decay of it and its daughter ytrrium-90, strontium-90 is rated as one of the most hazardous fission products. As a result the recommended maximum permissible concentration (occupational, 40 hour week) of strontium-90 in drinking water is 4×10^{-6} microcurie per milliliter[1]. This concentration is equivalent to 2.9×10^{-11} gram of strontium-90 per liter.

The maximum permissible concentration recommended for broader segments of the population is as much as one hundred times lower. From the above figures it is apparent that extremely olose control must be exercised over the fission products to prevent their dispersion to the environment in hazardous amount.

Up to the present time the required degree of control has been achieved by storing the solutions of fission products in tanks. This method has been safe, but its safety over the lifetime of the fission products has been questioned because the tanks are subject to corrosion or damage from other cause. The storage tanks are expensive, and large numbers would be required to contain the fission products from a sizable nuclear power installation.

Since it is the prevention of release to the environment that is of most concern and since the mobility of the ions in solution is objectionable, an obvious approach to the problem is to fix the fission products in a stable solid for disposal.

The use of glass as a suitable solid is being investigated by Atomic Energy of Canada, Ltd., in a research program that was begun in 1954. Glass was selected on the grounds that it was easy to make and was as durable a material as one could expect to make containing the many elements—fission products, corrosion products and possibly fuel sheathing materials—that are, or may be, present in the solutions resulting from fuel reprocessing.

Character of Fission-Product Solutions

The fission products comprise the elements between gallium and dysprosium. Each is present to an extent dependent on its yield in fission and its behavior during processing. Chemical reprocessing of the nuclear reactor fuel results in contamination of the solutions by corrosion products from the processing equipment. Also, if the sheathing material is not removed from the fuel prior to dissolution or if there are alloying elements in the

fuel, these will be present in the solutions. With efficient processing only insignificant amounts of uranium and plutonium are left with the fission products, but significant amounts of the transplutonic elements are present.

The Canadian Nuclear Power Program is directed toward the development of reactors cooled and moderated with heavy water and fueled with natural uranium dioxide clad in a zirconium alloy. This fuel will be desheathed and the UO_2 will be dissolved in nitric acid and processed by solvent extraction. The solution containing the fission products will be evaporated to a concentration of 35 grams of fission products per liter (rare gases and other volatiles excepted). The processing and evaporation steps are expected to add about 10 grams of corrosion products per liter to the solution. This, then, is the solution that the process must be designed to treat.

The development work to date has of necessity been done with solutions that are rather different in composition than that described above. The analysis of a typical solution is given in Table I. It will be noted that the content of corrosion products and of uranium is considerably higher than will be the case in the future. This is the result of past use of inefficient processing methods. The content of fission products is perhaps a factor of ten lower than that expected in future waste.

Satisfactory glass has been made with the solution described in Table I, and it has been shown that the rate of release of fission products into water from such a glass is fairly insensitive to variation in quantity of the oxides added via the solution. Glass of good appearance has been made with a non-radioactive solution simulating the future concentrate described above, and it is expected that when an active glass of this type is tested the results will be good.

Table I

ANALYSIS OF FISSION-PRODUCT SOLUTION

FEBRUARY, 1959

Acidity	8N HNO_3	
Density	1.39 g/ml	
Total Solids	227 mg/ml	
Non Volatile Solids	100 " "	
Na	28.5 " "	
Fe	17.1 " "	
U	9.2 " "	
Al	3.2 " "	
Cr	2.9 " "	
Ni	1.7 " "	
Mg	1.3 " "	
Pu	1.2 mg/l	
Total β	4.2×10^{10}	disintegrations/min-ml
Cs-137	2.0×10^{10}	" " "
Sr-90 + Y-90	1.7×10^{10}	" " "
Ce-144 + Pr-144	4.2×10^{9}	" " "
Ru-106 + Rh-106	4.2×10^{8}	" " "

Properties Required of the Glass

The principal reason for putting fission products into glass for disposal is to render them practically immobile. The first prerequisite of the glass is therefore that it should resist the agencies that will, or may, affect it during the hazardous lifetime of the fission products. The glass should also incorporate the fission-product and corrosion-product oxides easily.

The useful lifetime should be 250 to 1000 years or more to permit essentially complete decay of all fission products of half-life less than 50 years. The method and location of the disposal will have to be chosen with due regard for the fission products of much longer half-life and, probably more important, for the presence of transuranic elements. It is felt that the properties of glass are sufficiently known that they can be relied on over the minimum period of time suggested above.

The external agencies that may be expected to cause dispersion of fission products from the glass are of two types:

1. Physical disturbances, such as military operations, earthquakes and the like that would be expected to disperse the solid glass as such, and
2. Corrosion by water, that would disperse fission products as an aqueous solution.

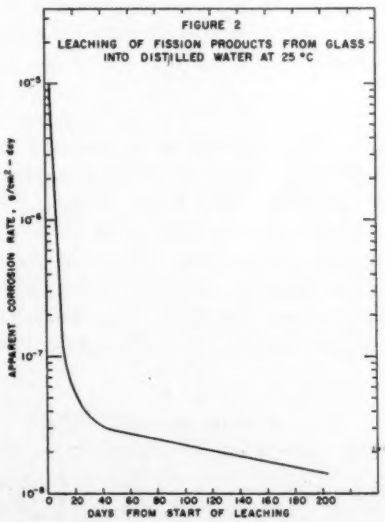


FIGURE 2
LEACHING OF FISSION PRODUCTS FROM GLASS INTO DISTILLED WATER AT 25 °C
APPARENT CORROSION RATE, g/cm² - day
DAYS FROM START OF LEACHING

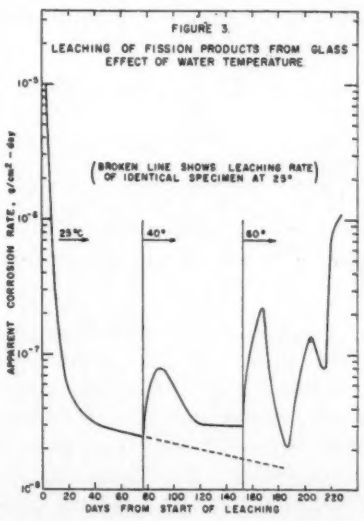
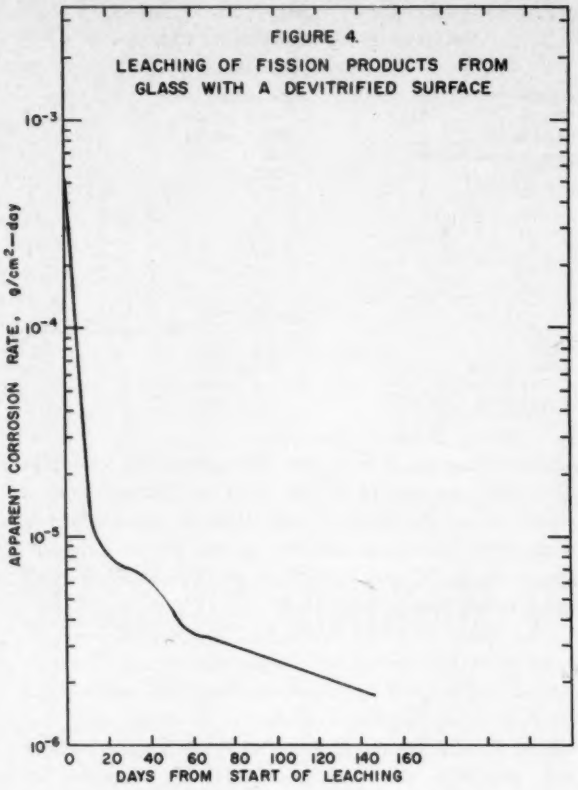


FIGURE 3
LEACHING OF FISSION PRODUCTS FROM GLASS EFFECT OF WATER TEMPERATURE
(BROKEN LINE SHOWS LEACHING RATE OF IDENTICAL SPECIMEN AT 25°)
25°C
40°
60°
APPARENT CORROSION RATE, g/cm² - day
DAYS FROM START OF LEACHING



Both can be prevented by proper choice of disposal method and location, but it is questionable whether protection against water can be guaranteed for long periods of time in a man-made storage area such as a concrete vault, a mine or other similar location.

The presence of the decaying fission products might be expected to produce effects that could alter the corrosion resistance of the glass and it is necessary to show that these are either of no significance or that it is necessary to control them. As the fission products decay they emit beta particles and/or gamma rays that are absorbed either in the glass or in its surroundings. The effects are three-fold:

1. The glass may suffer damage because of the intense irradiation.
2. The absorption of the energetic rays and particles will result in temperature increase to an extent dependent on the age and concentration of the fission products, the properties of the glass, the configuration of the disposed glass and in what it is disposed.
3. Beta-decay of the fission products produces elements of higher atomic number.

Radiation damage and changing composition may affect both the physical integrity of the glass and its resistance to attack by water. Increasing the temperature of the glass will increase the rate of devitrification, and this may result in reduced physical integrity and durability in water. Higher temperatures may also anneal out any damage caused by fission-product decay. In the case of glass immersed in water, increased temperature would be expected to result in increased release of fission products.

Selection of a Suitable Glass

The selection of a suitable glass was governed by several considerations. It was considered highly undesirable to operate in a system in which a severe radioactive dust hazard was created. This was felt to eliminate from consideration a continuous melting process because of the problems of maintaining a melting tank in intensely radioactive service, and because of the need for direct firing. It was considered essential to make the most resistant glass possible with due regard for the expenditure permitted on waste disposal in producing economical nuclear power.

To achieve high chemical resistance it is necessary to go to a glass of high melting range, but there is a practical limit imposed by the available heating methods. Silicon carbide resistors seemed most appropriate and with these the operating temperature is limited to 1300 to 1350°C.

Drying of a slurry was considered undesirable because of the probability of bubbling and bumping. It was felt that if the solution could be contained in a gel, the latter could be dried without serious dust formation. The simplest method of getting the liquor into a gel was to use as the glass-forming raw material a silicate that was unstable in acid. Of those considered, nepheline syenite, which is a mixed silicate rock of the approximate analysis shown in Table 2, was readily available, inexpensive and well-suited to the purpose. Glasses comprised principally of nepheline syenite were capable of having added to them the oxides present in the fission-product solution and of being melted at 1350°C or less depending on the amount and type of flux added.

Most of the work has been done with a glass based on a mixture of 85 wt per cent nepheline syenite—15 wt per cent calcium oxide. This glass melts and fines adequately at 1350°C, readily accepts up to 10 wt per cent of other oxides from the solution and is at least as resistant to water as many other compositions that have been tested.

The Process

Fission products have been incorporated into glass by the process shown in Fig. 1. Nepheline syenite (N.S.) and slaked lime were mixed in the weight ratio 85 N.S. to 15 CaO. This powder was tumbled with 10 weight per cent water to form pellets. The pellets were screened and those that were plus 20 mesh minus 6 mesh were used in the process. The pellets and the solution containing fission products were mixed in a 4.5 liter Denver

Table II

COMPOSITION OF NEPHELINE SYENITE

SiO_2	60 per cent	CaO	< 1 per cent
Al_2O_3	24	Fe_2O_3	
Na_2O	10	MgO	
K_2O	5	TiO_2	

fireclay crucible by alternately adding pellets and solution in small lots until the crucible was full. In this way two kilograms of solids (dry basis) were mixed with two liters of solution to form a reasonably homogeneous mixture. Silica gel was precipitated at a rate depending on the acidity of the solution in sufficient quantity to cause the entire mixture to solidify. The mixture was then fired in two stages, first, to 900°C to dry it and decompose the nitrates present and, second, to 1350°C to melt it. Reasonably well-fined glass was obtained by keeping the melt at 1350°C for one hour, and the glass was adequately annealed while cooling to room temperature at the natural cooling rate of the furnace.

Two of the fission products, ruthenium and cesium, were partially evaporated from the mixes during processing. To prevent the escape of these radioactive elements the furnaces were ventilated and the air exhausted from them was passed through a gas-cleaning system. With the mixes gelled as they were there was no significant problem with dust. Ruthenium, which evaporated as RuO_4, was removed by reaction with iron oxide. Cesium, which evaporated as cesium vapour, was removed by reaction with a silicate. In the process both were removed at once by passing the exhausted air at 400 to 700°C through a short bed of granular firebrick on which was deposited iron oxide. The air was then passed through a cooled tower packed with Raschig rings to condense the steam and nitric acid and to remove the nitrogen oxides present. The condensate was recirculated through the tower as absorbent. A second liquid scrubber containing caustic removed the remaining oxides of nitrogen, after which the air was filtered and dispersed to the atmosphere.

Usually 40 to 60 per cent of the ruthenium and one to two per cent of the cesium added to the crucible were evaporated. The packed adsorber removed 95 to 99 per cent of each of these elements from the exhaust air, and the rest was removed in the two scrubbers. The adsorbent, contaminated with ruthenium and cesium, can be added to nepheline syenite and lime and made into glass for disposal. The acid condensate will be recycled to the process via an evaporation step. In a large-scale process the caustic scrubber would not be used as it creates a high-solids waste stream.

This process as described has been used to make two-kilogram pieces of glass containing up to 50 curies of six- to eight-year-old mixed fission products. A scaled-down version has been used to make 5-gram samples of the same relative concentration. The samples have been used chiefly to determine the rates at which fission products were released from them, but some have been used for some preliminary tests of other effects.

Tests and Results

Although glasses of about twenty-five compositions based on nepheline syenite have been tested, leaching studies have shown that the durability of many was quite similar and that none was outstanding. It is accepted that the attack of glass by water or other mild aqueous reagents results in the preferential removal of some of the elements, particularly the alkalis and alkaline earths. This fact notwithstanding, the results in the present work have been reported as though uniform corrosion of the glass surface were occurring. The derived numbers were therefore recorded as grams of glass removed per square centimeter of surface exposed per day of contact (g/cm²-day). It was assumed that the concentration of the radioactive elements was uniform throughout the glass and the activity found in the water was converted to a corresponding weight of glass. The exposed surface was taken as the geometric surface.

Glass made by incorporating the elements present in the solution described in Table I into a mixture of nepheline syenite and lime has been most used in this work. While it is not the most durable glass tested the results obtained with it will serve to illustrate the principal properties of the glass and how they relate to the problem of fission-product disposal. The composition of the glass is given in Table III.

Leaching in Cold, Slowly-flowing, Distilled Water

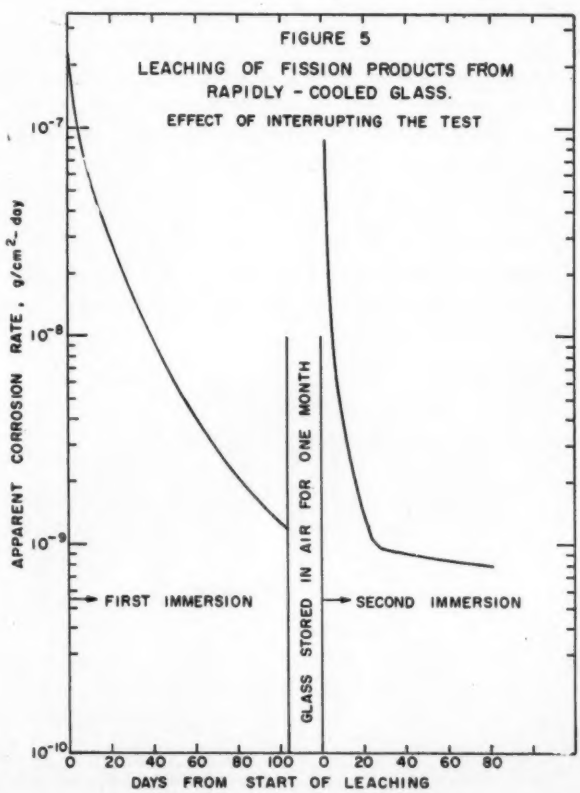
Conical 5 g samples were tested by immersing them in 10 cc. of distilled water at room temperature in polyethylene vessels. Distilled water was added and removed dropwise at an average rate of 10 cc./day. Part or all of the effluent water was evaporated on an aluminum

(*Continued on page 292*)

FIGURE 5

LEACHING OF FISSION PRODUCTS FROM RAPIDLY - COOLED GLASS.

EFFECT OF INTERRUPTING THE TEST



The Development of the Pressed Glass Industry in America

by Albert Christian Revi

● PERHAPS THE MOST SIGNIFICANT CONTRIBUTION made by American craftsmen to the glass industry's development in the nineteenth century was the discovery of a mechanical means for producing press-molded glass articles. Pressed glass was available in ancient Egypt during the 18th Dynasty (1412-1375 B. C.) as small, press-molded cups and amulets. The technique made its appearance periodically throughout the ages in similar forms. In the eighteenth century glass stoppers for decanters were molded with a small hand-press.

Contemporary historians, and even those in the trade at that time, agree that the art of pressing glass was primarily an American contribution. Following her visit to Bakewell & Company's glasshouse, Mrs. Anne Royal, the author of *Pennsylvania, or Travels Continued in the United States* (1829), had this to say about Pittsburgh's pressed glass: "They have introduced a fashion of stamping figures on glass while it is warm, also molding glass which is done neatly in the same way metal is cast. Everything made of glass is found here, and I would say the patterns and clearness of the pieces, are equal, if not superior, to the Boston Glass." In *America and the Americans*, James Boardman (London—1833) gave a short account of his visit to the Fair of the American Institute of the City of New York in the Fall of 1829. He was most impressed by the "pressed glass; which was

FIG. 1. Illustration from Apseley Pellat's "Curiosities of Glass Making". Shows early glass-press in operation.

far superior, both in design and execution, to anything of the kind (he) had ever seen either in London or elsewhere." Boardman credited its invention to Americans and predicted it would prove of great national importance.

George Dodd (*Curiosities of Industry*, London—1857) wrote, "Our American brethren seem to have been the first to introduce a mode of manufacturing glass by pressing, being one of the very few varieties in which blowing is not required."

In *Curiosities of Glass Making* (London—1849) Ap-

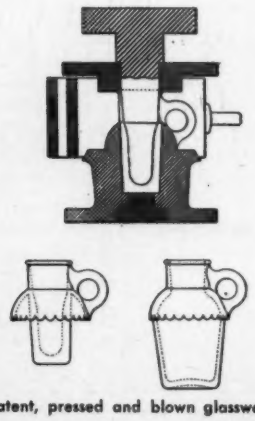


FIG. 2. Ripley's patent, pressed and blown glassware. Aug. 25, 1891.

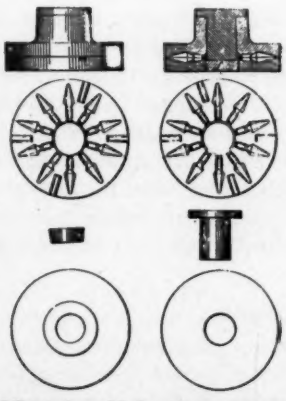


FIG. 3. Hiram Dillaway's mold for glass stoppers. Aug. 21, 1841.

sley Pellat refers to the new process as "American Pressed Glass."

But while his contemporaries abroad were lauding American ingenuity for re-discovering this important manufacturing technique, Deming Jarves, an American whose name was so prominently linked with the early pressed glass industry, was trying to deflect credit to English and Continental manufacturers. Perhaps the unpopular feeling among the glass workers toward this innovation in glass production prompted this denial on the part of Mr. Jarves, but it seems unlikely that a man of his mental stature would allow any fear for his personal safety to dissuade him from accepting so important an honor for his country.

In *Reminiscence of Glass Making* (New York—1865) Jarves revealed that almost forty years prior he had been importing "Holland salts made by being pressed in metallic molds, and from England glass candlesticks and table centre-bowls, plain, with pressed square feet, rudely made, somewhat after the present mode of molding glass."

The world seemed ready to agree that the introduction of pressed glassware was an American contribution, but here at home the issue of who was "first" was not so easily resolved. George and Helen McKearin (*American Glass*, New York—1941) report that "when Professor Silliman was gathering data for his treatise on glass for *The World of Science, Art and Industry* (New York, 1854) he was informed by Joseph N. Howe, agent for the New England Glass Company, that the 'validity and originality' of the (Robinson-Whitney) 'patent' (November 4, 1826) was contested by 'powerful Pittsburgh parties'—undoubtedly Bakewell & Company—but was sustained by a Philadelphia court." The case for the "powerful Pittsburgh parties" was most certainly based on the patent issued to John P. Bakewell, September 9, 1825.

The patent records for the first half of the nineteenth century are somewhat incomplete due to the fire of December 17, 1836, which destroyed much of the Patent Office and its records. From what fragmentary patent evidence we can piece together, we get the following facts about the Bakewell and Robinson-Whitney patents.

The records at our disposal show that on September 9, 1825, a patent was issued to John P. Bakewell of Pittsburgh, Pennsylvania, for producing "Glass Furniture (Knobs)." Mr. Bakewell was a member of the well-known and respected glass manufacturing firm of Bakewell & Company whose founder, Benjamin Bakewell, was described by Deming Jarves as "the father of the flint glass business in this country."

The patent issued to Enoch Robinson and Henry Whitney, November 4, 1826, appears on the available patent records as a process for "Making Glass Door Knobs"—nothing more.

The possibility that John P. Bakewell's patent was a means for producing pressed glass furniture knobs is not as remote as it might seem to be in view of the Silliman report. It is significant, too, that prior to the Bakewell patent we could find no previous mention of a patent for glass knobs of any kind.

The Mac Manus report (*A Century of Glass Manufacture*—1818 to 1918, by Theodore F. Mac Manus, Toledo, Ohio, 1918; privately published by the Libbey Glass Company) gives credit for the invention of a glass press to Enoch Robinson and Henry Whitney, but cautious researchers do not lean too heavily on his statements because of the obviously biased view of the author. Deming Jarves, besides crediting European manufacturers with the first pressed glassware, reported a much more advanced technique being manifested in the Mid West—specifically those articles produced by James B. Lyon & Company of Pittsburgh. Even at so late a period (1865) this could indicate that a much earlier start in pressing glass articles was made in the Pittsburgh area; certainly it purports that the art was more skillfully and effectively developed in the Mid West than in the Eastern section of the country.

The following patents represent specifications believed by the author to have a relation to the manufacture of pressed glass. Some of the patents reveal their connection with the industry in the very wording of the scanty evidence at our disposal.

The others, marked with an asterisk (*) imply a relationship and therefore cannot be omitted in this account.

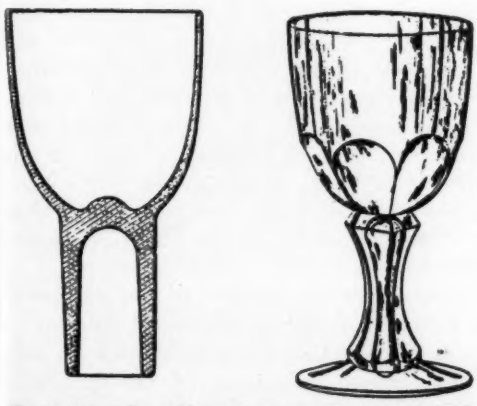


Fig. 4. Patent for goblet with air-trap stem. Nov. 3, 1874.

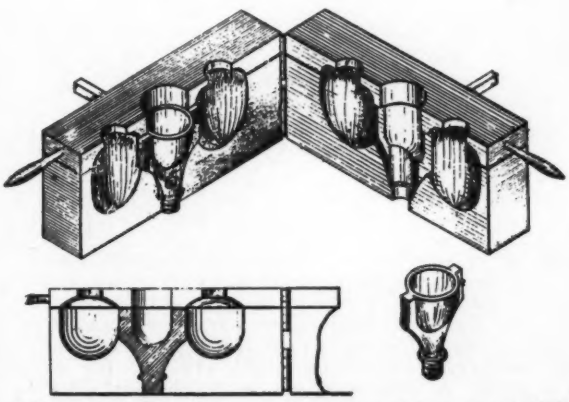


FIG. 5. Ripley's patent for a pressed and blown oil lamp. June 4, 1870.

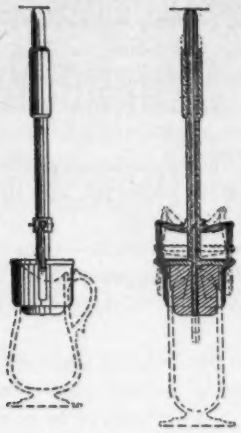


FIG. 6. William T. Gillinder's patent drawing specifications for a "blow pipe." Dec. 5, 1865.

Unfortunately, because of the fire mentioned previously, the information quoted directly from available patent records is all we have to present to the reader.

*September 9, 1825—John P. Bakewell, Pittsburgh, Penna.
"Glass Furniture (Knobs)".

*November 4, 1826—Henry Whitney and Enoch Robinson, Cambridge, Massachusetts.
"Making Glass Door Knobs".

October 6, 1827—John Robinson, Pittsburgh, Penna. The Stourbridge Flint Glass Works.
"Making Pressed Glass Door Knobs" (The first positive mention of pressed glass in the patent records.)

October 16, 1827—Phineas C. Dummer, Jersey City, New Jersey.
"Improvements in Moulds for Pressing Glass."

*October 16, 1827—G. Dummer, P. C. Dummer and Js. Maxwell, Jersey City, New Jersey.
"Improvement in the Combination of Moulds for Forming Glass."

*May 14, 1828—Thos. & John P. Bakewell, Pittsburgh, Penna.
"Making Glass Furniture Knobs or Handles."

December 1, 1828—Deming Jarves, Boston, Massachusetts.
"Improvement in the Mode of Pressing Melted Glass into Moulds."

*June 11, 1829—Elijah Skinner, Sandwich, New Hampshire.
"Manufacture of Glass Commode Knobs."

*June 13, 1829—Deming Jarves, Boston, Massachusetts.
"Manufacture of Glass Knobs and Screws."

*May 28, 1830—Deming Jarves, Boston, Massachusetts.
"Moulds for Glassmakers."

*October 19, 1830—Deming Jarves, Boston, Massachusetts.
"Manufacturing Glass Knobs."

November 26, 1830—Jno. McGann, Kensington, Pennsylvania.
"Manufacture of Glass Bottles, Decanters of all Kinds, and Other Pressed Hollow Glassware, with the Necks Smaller than the Cavity or Inside Diameter of the Vessel." (The articles were pressed in two molds forming the upper and lower portions of the bottle or decanter. Immediately after they were formed, and while they were still in a plastic state, the molds were turned over upon each other bringing the edges of the glass into exact contact, and with a slight pressure they were made to adhere. A similar patent was issued to William Leighton, Jr., February 9, 1875.)

FIG. 7. "Rock of Ages" bread plate. A pressed cameo technique by Thomas and James Atterbury. Patented Nov. 23, 1875.

*October 3, 1831—Spencer Richards, Cambridge Massachusetts and Attleborough, Massachusetts.
"Glass Door Knobs."

*November 19, 1833—Theodore T. Abbott, Canton, Massachusetts.
"Glass Knobs."

In the early days of the pressed glass industry the metal was squeezed into the recesses of the mold with presses operated by hand. While each factory made its own refinements according to its needs, basically the mechanism was like the one we show in Fig. 1, taken from Apsley Pellat's *Curiosities of Glass Making.*

The first improvement of any real merit in a manually operated glass-press was patented December 6, 1845, by Joseph Magoun of the New England Glass Company, Cambridge, Massachusetts. The improvement consisted of a sliding frame capable of receiving the cap-plate of molds of various sizes and design and too, making the frame, plate toggles, and the rest-block of the toggles adjustable with respect to the mold or bed-plate upon which it was placed.

On January 31, 1854, William O. Davis, then working in Pittsburgh, Pennsylvania, for the O'Hara Glass Company, registered his improvement for a glass-press. The invention consisted of the combination of a lever and toggle joint with a rocking shaft, swinging beam and connecting rods constructed in such a manner that the pressure was always central and vertical. The various parts were so arranged that little or no pressure was placed on the frame work of the press, most of the pressure being sustained by the swinging beam, rocking shaft and the rods which connected them. On August 25, 1863 Davis registered still another improvement in his press whereby he secured an accurately vertical movement of the piston-rod and plunger, but the operation was still manual.

A steam-operated glass-press was patented March 29, 1864, by Frederick McKee and Charles Ballinger. Not only was the plunger operated by steam-power but the separation between the plunger-rod and the piston-rod was such that the latter, after forcing down the plunger,

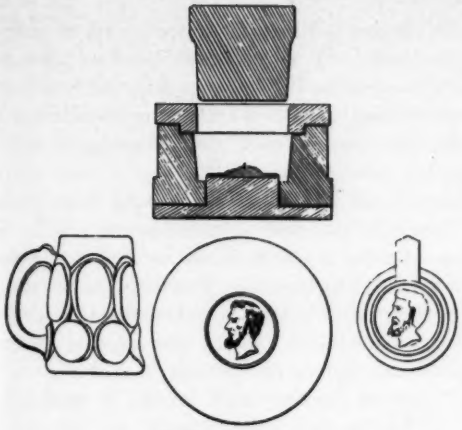


FIG 8. James and Thomas Atterbury's patent for pseudo-cameo incrustations. Oct. 17, 1865.

ros up, while the plunger remained momentarily down to firmly set the molded glass article in its form.

On May 9, 1871, William C. King of Pittsburgh, Pennsylvania patented his idea for a revolving block carrying a number of glass-molds and a device for revolving the block so as to place and hold the molds consecutively in position relative to the descending plunger. The invention was a refinement of a similar revolving mold patented June 8, 1869, by Robert D. Haines of the Boston Silver-Glass Company of Boston and East Cambridge, Massachusetts. Haines' revolving mold was turned by hand, whereas King's was operated by ratchet-teeth gears in connection with the manipulation of the plunger mechanism. The King device stepped up production considerably. On December 17, 1872 Mr. King filed two improvements on his invention, adding a tipping, or tilting, mechanism for manipulating the molds.

On March 5, 1872, Henry J. Leasure of Wheeling, West Virginia, patented an air-cooled glass-press. A system of pipes attached to the frame-work or other non-moving part of the glass-press were placed so that the air-discharge-openings played upon those parts of the

FIG. 10.
Jonothan Haley's patent for pressed glass tile. Oct. 25, 1892.

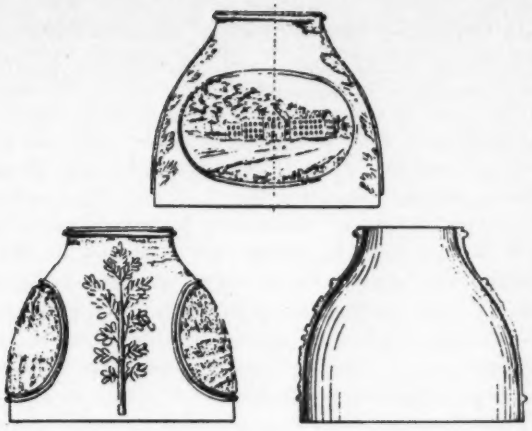


FIG. 9.
Pressed glass lithophane lamp-shade. Patented April 25, 1871.

mold to be cooled. Prior to this invention Leasure and James S. Gill filed a joint patent, dated December 4, 1866, covering a means for water-cooling the plunger of a glass-press. The invention consisted in forming the plunger so that a constant stream of water was made to pass through the plunger when it was in use.

A patent for a power-press was issued to Jonathan Haley of Pittsburgh, Pennsylvania, on May 13, 1873, which consisted of the following features:

1. A power-press in which the cranks were driven by a rotary shaft carried by, and in, the frame of the press, and arranged to connect with, and derive motion from, a belt.
2. The employment of a reciprocating plunger capable of yielding so as to exert an elastic pressure upon the material in the mold, in order to adapt itself automatically to variations in the quantity of glass put into the mold.
3. The combination, with the bed-plate of the press, of sliding mold-guides, arranged to be shifted at will from one side of the bed-plate to the other, under the plunger, whereby the press was made a double press, admitting one, two or more workmen at one press at the same time.

Author's collection.

FIG. 11. Honeycomb patterned oval-shaped footed and covered compote. The Boston Silver-Glass Co., ca/1869.

4. Combining with the crank-shaft and driving-shaft, a mechanism whereby the movement of the plunger could be automatically arrested at any given point desired by the operator.

Washington Beck of Pittsburgh, Pennsylvania, claimed to have invented the first practical power-press in his patent specifications dated May 4, 1875. His invention concerned the use of atmospheric pressure in combination with a movable plunger and glass molds. Beck claimed that prior to his invention "attempts" had been made to work molding-presses by steam-power, but owing to the accumulation of water of condensation in the steam-pipes and other passages the movements imparted to the pressing-head or plunger were irregular—too quick at one time and too slow at others—resulting in injuries to the molds and producing imperfect work.

On November 16, 1880, William Haley of Beaver Falls, Pennsylvania, patented molds "specially adapted for use in the steam-presses now coming into use in the manufacture of pressed glassware."

August 25, 1891, Daniel C. Ripley of Pittsburgh, Pennsylvania, registered his patent for the construction of a pneumatic glass pressing machine operated by either air or steam power (Fig. 2). Its main function was to enable the power to be applied precisely in proportion to the amount of glass in the mold.

The cooling of glass molds to prevent the accumulation of "shell" or "scum" occupied the attention of all the glass factories operating molding-presses. Hobbs, Brockunier & Company of Wheeling, West Virginia, utilized a cooling mechanism patented for them by J. H. Reighard on November 19, 1867. In this invention the plunger was made hollow and connected with a hollow piston-rod through which water was injected.

A similar, but more complex, water-cooled mold was patented July 7, 1868, by Hiram Dillaway of the Boston & Sandwich Glass Works. On July 7, 1868, Michael Sweeney of Sweeney, Bell & Company, Wheeling, West Virginia, patented a forced-air cooling system for cooling the plunger and surface of molds used in glass-pressing machines. Currents of air directed by pipes leading from a fan were made to play upon the parts to be cooled thereby keeping them at a uniform temperature, preventing the formation of "shell", and effecting an easy delivery of the glass from the mold.

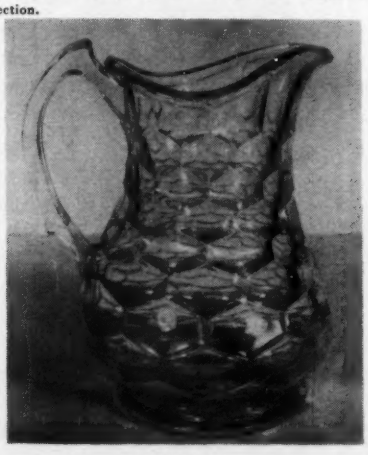
The preparation of molds had always been an expensive factor in the pressed glass industry. H. Sellers McKee patented an inexpensive method for preparing metal molds for figured table glassware on July 20, 1878. McKee first drilled circular indentations in the metal mold to the required depth. The angular decoration, shown in the patent illustrations as a series of "fine stars," was put into the small circular recesses made by the drill with a hard metal punch.

A simpler, more effective, and still cheaper method for producing figured glass molds was patented by Washington Beck September 2, 1879. To produce a granulated surface on pressed wares Beck prepared the inner surface of the mold with varnish sprinkled with an acid-resisting pellicle (usually asphaltum). He subjected the mold to hydrofluoric acid, either in a gaseous or liquid state. The acid bit into the metal not protected by the powdered resist, thus producing the granulated motif in intaglio. Mr. Beck's ideas included a method for etching elaborate designs on the working surface of a mold with transfers printed in acid-resisting inks. Still other means for producing designs of various kinds on the inner surface of a mold were suggested in the patent enumerations but basically the idea was the same—in each case the design was etched into the working surface of the mold. The difference in costs to the manufacturer between chipped molds and etched molds was tremendous.

On June 3, 1879, David Barker of Pittsburgh, Pennsylvania, patented a glass mold with interchangeable or removable print-blocks which enabled glass manufacturers to utilize the same basic mold for several different designs—another great saving to the industry.

FIG. 12. Compote or bowl on standard. Boston & Sandwich Lead glass. Colorless, grey cast, pressed bowl, with free-blown standard Massachusetts, 1828-35.
Corning Museum of Glass collection.

FIG. 13. Honeycomb pattern pitcher. Pressed and blown at Gillinder & Bennett Co., Philadelphia, Pa., formerly The Franklin Flint Glass Works. "Pat. 1865" is engraved on the handle. Height: 8½ in.
Author's collection.



Several improvements in pressing glass articles were patented in the nineteenth century. We believe the most significant to be these:

Hiram Dillaway's patent for a glass mold dated August 21, 1841, in which ten glass stoppers for decanters or cruets could be pressed in one operation. The patent drawings (Fig. 3), will give the reader some idea of the mold and its "fountain" which was the basic (and most important) feature of the patent. Its greatest interest now lies in the fact that it appears to be the first means patented in America whereby several glass articles could be pressed in one operation.

In June, 1942, *Antiques* published an interesting article by Lura Woodside Watkins based on an exchange of letters between Hiram Dillaway and Deming Jarves concerning an alleged infringement of the Boston & Sandwich Glass Works' patent. According to the letters quoted in the article, Patrick Slane of the American Flint Glass Works, South Boston, Massachusetts, developed a similar mold for pressing a salt or lampfoot and, at the same time, would make two or more stoppers. Jarves' letter to his attorney states "till this machine or mould was invented [Dillaway's] no mould had ever been used that could make more than one article but [at] one operation."

A note from Dillaway to Jarves dated "Sandwich, January 23, 1855" informed Jarves that the suit against Patrick Slane held Slane within his rights. Dillaway declared "it is a great pity that so valuable an improvement admitted to be so by all who are competent to judge should be lost—the thing is of much more importance than at first on account of its including press knobs &c, would it not pay to make an effort to retain the right in some form—if it can be without incurring too much expense."

Twenty-seven years later, on October 20, 1868, Daniel C. Ripley patented a mold for pressing two or more articles of glass in one operation. The very simply constructed mold shown in the patent drawings produced the foot of a lamp, a lamp-handle, and a glass stopper, all in one pressing operation. The individual parts were joined together by a "Sprue" or connecting "fin" which was easily broken. Reference was made in the specifications to Dillaway's patent of 1841 but it was carefully pointed out that the Ripley method was the first to produce several articles of different utility. (The multi-article mold developed by Patrick Slane was never patented.)

The manufacture of drinking glasses represented a large percentage of the output of most of the early pressed-glass factories. Various methods were devised and patented to produce attractive wares at the least possible expense to the manufacturer. Joseph Magoun of the New England Glass Company patented a mold for pressing stemmed and footed goblets September 25, 1847. The patent drawings show a goblet in their famous "Flute" design being press-molded. The cup and baluster stem came from the mold in a finished condition but the foot, which was cast in a bell-shape to facilitate its removal from the mold, was afterwards reheated and shaped into a circular disk with hand tools. A year later, October 24, 1848, Magoun patented a mold for producing incavo ornaments or depressions on the exterior surface of pressed glassware. The patent drawings illustrate a tumbler in the Cambridge glass works' "Ashburton" pattern.

On July 3, 1860, Andrew J. Sweeney of Sweeney, Bell & Company, Wheeling, West Virginia, patented an improvement in the form of a mold for making the foot on a pressed glass goblet without showing a mark of a mold-joint. The foot was cast in a bell-shape and afterwards spread out into a circular disk. Fire-polishing the goblet after it was fully formed was one of the patent stipulations. Its similarity to the Magoun patent of September 25, 1847, is apparent.

Robert E. Haines of the Boston Silver-Glass Company patented a mold on April 30, 1867, for producing footed and stemmed goblets without the need for hand tooling of any kind. On March 17, 1868, David Turpie, assignor

(*Continued on page* 296)

FIG. 14. Glass epergne. All parts were pressed and fitted together. Patented May 3, 1887, by Thomas B. Atterbury.

FIG. 15. "Ashburton" (Variant) handled mug. Possibly manufactured by the New England Glass Co., Cambridge, Mass. ca/1848.

Author's collection.

Electric Boosting And Bubbling for Glass Furnaces

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This paper was given at the Huttenverein der Glasindustrie in Frankfurt, October 23, 1958, and published in German in *Glastechnische Berichte*, Vol. 6, p. 240, 1959.

● IN THE PAST FEW YEARS, the practical techniques of electric booster melting and bubbling in glass furnaces have been developed to the place where these methods can be considered normal processes for the glass industry. The purpose of this paper is to set forth the practical benefits which the glass maker can expect from those processes.

ELECTRIC BOOSTING

The idea of electric boosting was patented first in the United States in 1934, but it did not start to come into general use until 1952. At that time, practical, simple, and inexpensive methods were developed whereby electric booster melting could be used in a glass furnace without modification of the furnace and without even waiting for the end of a campaign. This process became available at a time when production demands were high, and the process was adopted rapidly by many American manufacturers. In the succeeding years, the process was applied in many furnaces throughout Europe and in South Africa as well.

These electric booster installations were put in for a variety of reasons, each of which is described below.

1. Increased Output

More than half of the installations were made for the purpose of increasing the maximum tonnage output of the furnace. In such cases, the firing system of the furnace was being pushed to the practical limit, and it was not found possible to increase the furnace output by increasing the temperature. The electric booster system was able to increase the furnace output in such situations because the heat from the electric power was liberated within the glass itself. In this way, the glass bath was made hotter without a change of the superstructure temperature.

The first short furnace having a booster of this type had a normal maximum output of 56 short tons per day at a firing temperature of 2790°F. By means of a booster of 450 KW, the maximum output was raised to 72 short tons with a reduction of the firing temperature to 2720°F. This furnace had an area of 272 sq. ft. and was producing white flint glass for bottles.

Subsequently, it was found that a steady power input of 20 KW would produce one extra short ton of glass per day. Multiplying 20 KW by 24 hours, this means that the power consumption is about 480 KWH per short ton of extra glass produced by the booster. This is the normal figure, which corresponds closely with the theoretical amount of heat required to melt a ton of glass from batch.

Occasionally, the KWH requirement was reported to be much lower, even as low as 320 KWH per ton. In such cases, however, it was found that the extra benefit was due to correction of the convection currents. The convection currents in such tanks had been inadequate or poorly directed, due to faults in the charging system, fire control, or tank design.

The increase in furnace output which can be obtained from a booster depends partly on the tonnage which is obtainable by fuel alone. However, there have been several cases of increasing the output of a furnace by boosting to 3.75 short tons per square foot. In the writers' opinion even higher outputs could be obtained if desired.

In the usual production situation, an increase of furnace output of 30 or 40 per cent is often required. Such increases are easy to obtain by electric boosting. For example, a furnace producing 10 tons per day can be increased to 14 tons per day quite easily. A furnace producing 50 tons can be increased to 70 tons. Similarly, a furnace producing 100 tons can be increased to 140 tons.

In the first case, the increase of 4 tons would require a steady power input of 88 KW. In the second case, the increase of 20 tons would require a steady power input of 440 KW. In the third case, the increase of 40 tons would require a continuous power input of 880 KW.

These are all calculated at the rate of 22 KW for each metric ton of increase. This figure is generally the same for any color of soda-lime glass, although it is common in dark green furnaces that the stimulation of convection currents gives a higher efficiency than normal.

A 40 per cent increase in tonnage is not the limit. The output of some furnaces has been doubled.

2. Improved Quality

In some installations, the objective was to improve the glass quality as to cords and bubbles. The electrodes have the ability to create local turbulence in the glass in their immediate vicinity. This mixes the glass in such a way that cords are diminished. The homogeneity rating has often been raised, for example, from B minus and C plus to a consistent B plus.

The extra heat from the electric power makes the entire glass bath hotter, for better refining. For example, in cases where the seed count was higher than desired, the addition of 100 or 200 KW of electric power reduced the bubble count markedly, when there was no increase of production.

3. Reduction of Firing Intensity

Many electric booster installations have been made for the purpose of reducing the intensity of the fire. The furnace itself at high temperatures was able to produce all of the glass which was required. But these high temperatures were considered by the operator to be dangerous to the life of the superstructure refractories.

In one particular case, a furnace of 355 sq. ft. was producing 79 short tons per day, using fuel alone. The firing temperature was 2800°F. By the addition of 100 KW with no change in the furnace output, the firing temperature was reduced to 2765°F. This was considered a more reasonable operating temperature.

4. Reduction of Stone Loss

In the melting of dark glasses, a high loss of production (4 to 7 per cent has been reported) due to stones in the ware has often been encountered. It has been determined that this excessive stone loss has been caused by the lack of heat penetration from the flames to the lower levels of glass, whereby these lower levels may be as cold as 1800°F.

There have been many installations of the electric booster whereby the stone loss has been reduced from the high figures given above to the figures which are normal for white flint glass, ½ to 1 per cent. This has been accomplished by heating the lower levels of the glass with the electric booster, while at the same time increasing the output of the furnace according to one ton of extra glass for each 22 KW of steady power input. The reduction in stone loss comes as an extra benefit in addition to the increased tonnage.

5. Failure of the Firing System

Several boosters have been installed for the purpose of making up for the deficiency of the firing system at the end of a campaign. During the early part of the campaign, the furnaces were capable of producing the required tonnage. Toward the end, the regenerator chambers became clogged so that combustion conditions were not adequate for burning the right amount of fuel. In such cases, the electric booster supplied the missing heat.

As an example, a certain furnace normally producing 130 tons per day was down to 100 tons in the middle of the third year because of clogged checkers. It was even probable that the furnace would have had to be shut down in the middle of the busy season. This would have meant considerable freight cost in shipping the required tonnage of glass from another plant 1000 km. distant.

Instead, a 600 KW booster was installed with great speed, in 25 days. Immediately, the furnace was brought back up to the standard 130 tons for 3 months, and the furnace was operated for 2½ more months at somewhat reduced capacity and then was shut down at the normally scheduled time when the demand was decreased and the warehouses were full.

In another case involving a very large furnace, the furnace basin had been enlarged at a rebuild without making corresponding increase in the capacity of the firing system. The furnace was not able to burn fuel efficiently, and hence was not able to produce as much glass as the area would normally indicate. By means of a 1000 KW booster, the furnace output was brought up considerably and the difficulty of burning the fuel was relieved.

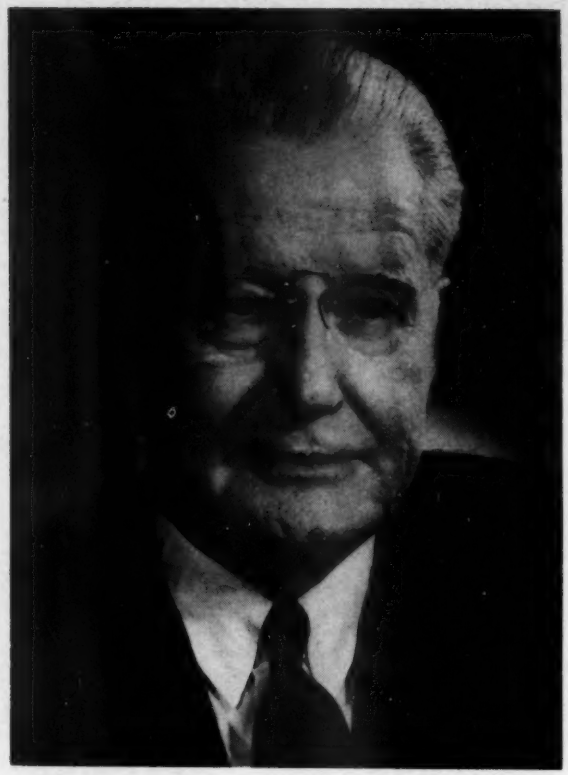
The same sort of benefits have been achieved in smaller furnaces as well.

BUBBLING

The idea of bubbling a melt of glass is very old indeed. It originated in the practice of plunging wet or combustible materials to the bottom of a pot in order to agitate and stir the contents. There has been some use made of continuous bubbling in continuous tanks in past years. Improvements in the method of bubbling have been made in the past 4 years. Also, techniques have been developed so that bubbling can be applied to a tank while it is hot, and operating, as well as when it is cold at rebuild.

Bubbling differs from boosting in that bubbling does *not* supply added heat to the tank. Bubbling only causes the cold glass to rise to the surface where it can absorb heat from the flames. This is beneficial in most tanks, but because of this absence of providing its own heat, the bubbling system is definitely limited in its ability to increase output. The most favorable applications of bubbling have been in colored glass tanks. In such furnaces,

(*Continued on page* 299)



John D. Biggers Retires

● AFTER 30 YEARS of guiding Libbey-Owens-Ford Glass Company, one of the largest flat glass manufacturers in the world, John D. Biggers has retired as chairman and chief executive. Listed among the 50 outstanding business leaders of the United States during two of these three decades he has received international acclaim as an industrial statesman.

Mr. Biggers joined the Owens Bottle Machine Company at a time when the glass industry was experiencing the dynamic changes wrought by Michael J. Owens' new automatic glass container forming machine. Under the tutelage of Edward D. Libbey and Mr. Owens, founders of the company, he held successive positions in finance, factory management, and sales.

Later, having resigned as vice president and general sales manager of Owens Bottle Machine Company, he traveled to London to become managing director of Dodge Brothers Britain, Ltd. He relinquished this position, however, after a year and returned to the United States as vice president of Graham Brothers Corporation, N.Y., a glass container manufacturer, which had transferred its interest to the rapidly expanding automotive industry. The company, and several associates, acquired the holdings of the late Edward D. Libbey in the Libbey-Owens Glass Company in 1927, and Mr. Biggers became a director.

He was elected president of Libbey-Owens-Ford Glass Company when Libbey-Owens Glass and Edward Ford Plate Glass Company merged in 1930. Annual sales of the new company amounted to $12 million in that year; in 1959 they hit a record-breaking $306,734,000. Mr. Biggers also directed the development of the company's fiber glass division which was purchased by the Johns-Manville Corp. last year.

Not a man to limit the applications of his talents, Mr. Biggers has also been active in governmental, civic, educational and welfare activities. During 1937-38 he served as Administrator of the U.S. Census of Unemployed, and prior to World War II he became Director of Production in the U.S. Office of Production Management. Appointed Minister to Great Britain in 1941 he flew to London to aid in coordinating war production and in 1946 he received the Presidential Medal for Merit.

Formerly president of the Toledo Museum of Art, he is now chairman of its executive committee, a trustee of the Edward D. Libbey Estate, moderator of the First Congregational Church, director of the University of Toledo and chairman of the building committee of Toledo Hospital. He holds honorary degrees from the University of Michigan, where he obtained his A.B. degree, and from the University of Toledo, Defiance College and New York University.

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NEWS
IN THE GLASS INDUSTRY

Personalities...

Paul S. Gruber

Manager and chief engineer of the furnace engineering division for Ferro Corporation. John A. Dvorak is now assistant chief engineer and Robert S. Hlivak is chief draftsman.

Benjamin P. Colosky

Heads the newly established technical service department of Corhart Refractories Company. The department will assist customers with technical problems in specifications and use of refractories and will be responsible for market and product development.

Benjamin P. Colosky

Vernon F. Kean

Vernon F. Kean

Appointed to the Ceramic Color and Pottery Frit Division sales and administrative staff of the O. Hommel Company. He will help to coordinate the division's increased sales activities both in the home office and in the field.

Robert M. Pattison

Elected President of the Houze Glass Corporation, Point Marion, Pa. He joined the company in 1954 and was vice president prior to this promotion.

Floyd A. Petee

Advanced to regional sales promotion manager for the Central Region for Libbey-Owens-Ford Glass Company. He succeeds L. J. Schenck, who became district distributor manager of the Toledo district.

Henry F. Dever

Transferred from Philadelphia to Minneapolis-Honeywell Regulator Company's headquarters in Minneapolis as head of the Industrial Products Group.

Raymond J. Corbett

Will represent the glass products division of Fischer & Porter Company in the Philadelphia area. The division's product line consists of precision industrial glass specialties and laboratory apparatus.

Sidney J. Stein

Vice president for International Resistance Company. He is also director of research and engineering. The organization is giving increased emphasis to such areas as thin semiconductor films, electronics and new resistor types.

Philip E. Neff

Dr. Sidney J. Stein

Philip E. Neff

Assistant to the president of The O. Hommel Company in plant administration and sales promotion.

T. A. Jones

Manager, Washington office, American Potash & Chemical Corporation. He will maintain local business contacts for the company's national northern division and act as a liaison with governmental agencies.

William C. Decker

Re-elected president of Corning Glass Works. Also re-elected were Charles D. LaFollette, financial vice president; Amory Houghton Jr., staff vice president; Frederick H. Knight, secretary; Thomas Waaland, treasurer; John L. Ward, controller; Henry H. Sayles and William W. Sinclaire, assistant secretaries; C. Henry Kruidenier, assistant treasurer, and Robert W. Foster, assistant controller.

Amory Houghton was re-elected chairman of the board and granted continued leave of absence during the period of his service as United States Ambassador to France.

Larry R. Madden

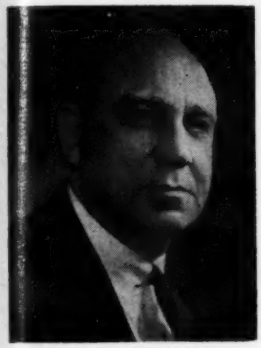
West Coast senior sales representative for the industrial bulb sales department of Corning Glass Works. He will handle sales of glass bulbs, tubing and components for radio, television and special electronic tubes.

George P. MacNichol, Jr.

Re-elected as president of Libbey-Owens-Ford Glass Company succeeding John D. Biggers who has retired as chairman and chief executive. (See p. 276).

Curtis W. Davis was elected executive vice president and will supervise plants and production facilities, all technical divisions, industrial relations, industrial engineering and the purchasing and traffic departments.

Other officers elected by the board were F. E. Cazayoux, vice president-finances; S. S. Wall, vice president; E. M. Everhard, vice president; L. G. Bryan, vice president; W. H. Hasselbach, vice president-engineering; C. F. Hegg, vice president-sales; H. M. Alexander, vice president-technical service; H. G. Orser, vice president-special products production; A. P. Plant, vice president-industrial sales; E. R. Pierce, vice president-sales; J. M. Ashley, vice president-public relations; R. S. Carey, secretary and general counsel; R. M. Weter, treasurer, and H. B. Ryan, comptroller.



George P. MacNichol, Jr.

Curtis W. Davis

Merrill S. Saneraint

Manager of wholesale and utility sales for Westinghouse Electric Corporation's lamp division. He will have special responsibility for lamp sales activities concerning utilities, rural electrification administration and primary wholesale distributors in the electrical and hardware fields.

Arlyn C. Anderson

Field representative for Libbey-Owens-Ford Glass Company's distributor sales division, San Francisco. Other newly appointed field representatives are: James M. Brown, Philadelphia; Roy A. Ferguson, Detroit; John B. Kemmerling, Indianapolis; R. Jack Light, St. Louis; Robert N. Colvin, New York; N. Thomas Barnes, Chicago, and William J. Yohe, Atlanta.

John P. Gleason

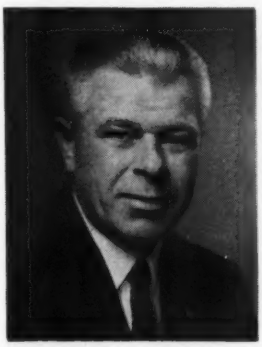
Assistant director for Mobilization Planning, Containers and Packaging Division, Business and Defense Services Administration, U.S. Department of Commerce. Gleason is sales manager of the Electronic Products Division of Kimble Glass Company, a subsidiary of Owens-Illinois Glass Company.

Theodore R. Vogt

Assistant secretary for Owens-Corning Fiberglas Corporation. He joined the company's legal patent department in 1950.

A. J. Lubertine

Works manager for Pemco Corporation. Formerly general superintendent, he headed the color manufacturing department and the control division. Frank E. Chapman, Jr., previously manager of quality control, is now plant superintendent. Richard H. Turk, III, has been elected a vice president of the company and will be responsible for all manufacturing and production.



A. J. Lubertine

Louis J. Melillo

Louis J. Melillo

Plant manager of the Bremen, Ohio, plant of Modiglass Fibers, Inc. He has been with the company since September, 1959, and was previously employed in the Fiber Glass Division of Pittsburgh Plate Glass Company.

Dr. Alan D. Franklin

Chief, Mineral Products Division, National Bureau of Standards. He has been acting chief since November, 1959, when he succeeded Dr. Irl C. Schoonover and will direct the Bureau's research on properties of non-metallic inorganic solids, including glass, ceramics and refractory oxides.

Robert D. Murphy

Elected Catholic national co-chairman of the National Conference of Christians and Jews. Mr. Murphy was formerly Under Secretary of State for Political Affairs. He resigned from the State Department and joined Corning Glass Works in January as a member of the board of directors and president of Corning Glass International.

Guy Rindone

W. B. Achenbach

Guy E. Rindone

Elected chairman of the Glass Division of the American Ceramic Society for 1960-61. He has served on various committees of the Division and is currently vice-chairman.

Dr. Rindone has conducted fundamental research in glass technology on nucleation and crystallization processes, phase separation of salts, discoloration of glass by sunlight, gas evolution from glass, electrochemical cells of glass, high temperature heat contents, and anelasticity.

Roy N. Sundstrom

Thomas J. Rowe

Roy N. Sundstrom

Senior project engineer, Electrical Products Division, Corning Glass Works. Lawrence B. Hausheer succeeds Sundstrom as plant quality and process engineer and Walker T. Howell becomes plant industrial engineer.

W. B. Achenbach

Director of business planning and analysis for Kimble Glass Company.

William A. Miller

Supervisor of research, fused-cast refractories for glass plant service at Harbison-Carborundum Corporation. He has participated in quality control, product engineering and process engineering, in addition to aiding the beginning of the fused-cast refractories plant at Falconer, N. Y.

C. Burton Clark, formerly senior mineralogist with Harbison-Walker Refractories' research department, has joined the Harbison-Carborundum Corporation as research supervisor, fused-cast refractories for metal industries. His research work has concerned the field of atmospheric effects on refractories in service and new techniques of spectrographic analysis.

Thomas J. Rowe

Financial vice president and treasurer, Knox Glass, Inc. He succeeds Alexander W. Lansberg who is now vice president and executive assistant to Dr. Arthur W. Wishart, president.

Obituaries...

Elmer W. Dany

Elmer W. Dany, vice president, furnace engineering division, Ferro Corporation, died March 29th. He joined Ferro in 1925 and became vice president in 1946.

Henry F. Teichmann Sr.

Henry F. Teichmann, Sr., president of Henry F. Teichmann Inc., died March 25, in Washington County, Pa.

Mr. Teichmann was associated with the steel industry for many years as an engineer before he joined the Frazier-Simplex Company where he later became Chief Engineer. In 1947 he and his son, Henry F. Teichmann, Jr., established Henry F. Teichmann, Inc., as engineers to the glass industry.

Companies...

Sylvania Electric Products, Inc.

Is combining the principles of electroluminescence and photoconductance for use in memory and logic functions in computers and as data display devices. The new light source can be used in electronic equipment for data processing, countermeasures, medicine, radar, and air and sea traffic control. In combining the two principles the company has created miniaturized photoconductive-electroluminescent switches for computer operations. The switches translate decimal information into visual display, convert from the binary number system to the decimal system and vice-versa. Electroluminescence differs from other light producing methods in that it creates light through the excitation of phosphors placed in an electrical field.

Vitro Chemical Co.

Is consolidating its manufacturing activities and will produce its entire line of chemicals at the Chattanooga, Tenn., plant. The firm is a subsidiary of Vitro Corporation of America which owns 91.6 per cent of the stock. The Societe de Producits Chimiques des Terres Rares owns the remaining 8.4 per cent.

Research laboratory of American Nepheline Corp., Columbus, O., a recently incorporated subsidiary of American Nepheline Ltd., Toronto, Ont.

Anchor Hocking Glass Corp.

Moved the Package Division and Tableware Division to modern quarters at Two Parkway Center, 875 Greentree Road, Pittsburgh 20, Pa., on April 29.

Wheaton Glass Co.

Purchased the Owens-Illinois Glass Company's glass container plant in Terre Haute, Ind. The 22 buildings with 236,000 sq. ft. of space have been inoperative for over ten years.

Owens-Illinois Glass Co.

Purchased a minority interest in Companhia Industrial Sao Paulo E Rio, a leading glass container company in Brazil A technical assistance and patent license agreement with the South American organization was signed April 15.

The plant also operates plants in Rio de Janeiro and Sao Paulo, which produce flint, amber, green and blue glass for beer, beverages, drugs, chemicals, and other products.

Reichhold Chemicals, Inc.

Negotiating with Nicolet Industries, Inc., for the purchase of the Modiglass Corp. Modiglass produces approximately five million square feet of fiber glass mat at its Bremen, Ohio, plant. The Reichhold company manufactures many of the plastic resins used to reinforce fibrous glass.

Westinghouse Electric Corp.

Presented a $9000 patent award to three engineers in the company's lamp division. George Meister, research engineer, Albert Wainio, development engineer, and Stanley Lopenski, equipment design engineer, were awarded $3000 each in recognition of their contributions to the invention of an electrostatic bulb-coating machine. The machine has made possible a more uniform silica coating on the interior of light bulbs. The millions of particles in the coating diffuse the light from a filament and eliminate the "hot spot" of ordinary bulbs. A soft glareless light is created which is radiated evenly from the entire bulb surface.

American Nepheline Ltd.

Incorporated a new subsidiary, American Nepheline Corporation, 4720 Kenny Road, Columbus, O., to provide U. S. headquarters for ceramic research and technical service.

The parent company has had a research program in operation since 1937 at Ohio State University on the development of Nepheline Syenite in ceramic applications. The association with Ohio State University will be continued in connection with a basic research project.

Dr. C. J. Koenig, with the program since its beginning, has been appointed vice president-research for the new firm and will continue as director of research for American Nepheline Limited. Dr. R. C. Wilson, technical service representative, will handle technical service work for both companies.

Emerson Radio & Phonograph Corp.

Formed a new electronics company called Emertron, Inc. The new company has been incorporated with 5,000,000 shares of stock. It will not be concerned with Emerson's electronic consumer products but will handle government, commercial and industrial orders. This will include communication and navigation equipment, radar systems, automation, transistorization and field engineering services.

FINANCIAL DATA

Corning Glass Works

	1960 (first quarter)	*1959*
Net earnings	$ 5,947,782	$ 5,756,754
Net sales	$51,169,075	$43,108,268

Jeannette Glass Co.

First quarter sales for 1960 are 40 per cent ahead of last year. Earnings in 1959: $100,123; in 1958: $63,161.

Knox Glass, Inc.

	1960 (first quarter)	1959
Net earnings	$ 207,108	$ 185,013
Net sales	$9,446,190	$9,130,810

Owens-Illinois Glass Co.

	1960	*1959*
Net earnings	$ 7,813,941	$ 7,834,997
Net sales	$130,539,497	$123,396,514

Pittsburgh Plate Glass Co.

Boosted 1960 first quarter earnings up to $1.20 a share, 38 cents a share higher than the 1959 first quarter.

Shatterproof Glass Corp.

	1959 (End of fiscal 1959)	1958
Net earnings	$ 1,023,000	$ 399,812
Net sales	$17,400,000	$13,100,000

INVENTIONS AND INVENTORS

Annealing and Tempering

Apparatus for bending glass sheets. Patent No. 2,920,423. Filed October 7, 1955. Issued January 12, 1960. No sheets of drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Company by Frank J. Carson.

The important object of the present invention is to provide apparatus for bending glass sheets to complex curvatures, and twisting the sheet as it is being bent.

A further object is the provision of an improved bending mold of the type having movable mold sections.

There were 4 claims and the following references cited in this patent.

United States Patents

2,348,278, Boyles et al., May 9, 1944; 2,518,591, Smith, Aug. 15, 1950; 2,608,030, Jendrisak, Aug. 26, 1952; 2,608,799, Babcock, Sept. 2, 1952; 2,691,854, Rugg, Oct. 19, 1954; 2,695,476, Jendrisak, Nov. 30, 1954; 2,736,140, Black, Feb. 28, 1956; 2,744,359, Jendrisak, May 8, 1956.

Foreign Patents

710,393, Great Britain, June 9, 1954; 727,200, Great Britain, Mar. 30, 1955.

Feeding and Forming

Method and Apparatus for Sealing Metal to Glass. Patent No. 2,902,796. Filed September 27, 1955. Issued September 8, 1959. No sheets of drawings; none reproduced. Assigned to Western Electric Company, Inc., by John K. McDuffee.

Metal anode terminals are first oxidized (it is well known in the vacuum tube art that glass will wet to an oxidized surface much easier than to an un-oxidized one) and the oxidized terminals are then assembled in substantial fusing relation with the glass seal members, the glass being pre-formed to receive the terminals and thereby shield the desired fusing surface. The terminals and the glass members are then heated to fusing temperature while a reducing gas is applied to the terminals to remove the oxide from the unshielded surfaces adjacent the desired fusing surface. Then when the glass surrounding the fusing area becomes plastic, it will wet only to the remaining oxide surface thereby producing the desired, accurately defined seal.

The invention also includes a metal heat plate adjustably positioned on a spindle for supporting the parts to be fused. The spindle limits or fixes the final positioning of the metal member when the glass becomes plastic and settles, the heat plate absorbing energy from an induction heating coil which heats the metal member and surrounding glass to fusing temperature. A reducing gas is applied both above and below the fusing or seal area for removing the oxide from the unshielded pre-oxidized metal member, the desired fusing surface on the metal member being shielded by the abutting glass of the glass member. A bellows arrangement in the gas supply line to the lower side of the fusing area is used to pulsate the pressure of the gas supplied thereto to agitate the members to move them into sealing contact for seating the metal in the plastic glass.

There were 4 claims and the following references cited in this patent.

United States Patents

1,692,998, Ruben, Nov. 27, 1928; 2,385,083, Kemerer, Sept. 18, 1945; 2,446,277, Gordon, Aug. 3, 1948; 2,450,130, Gordon et al., Sept. 28, 1948; 2,483,205, Jones, Sept. 27, 1949; 2,515,706, Greiner et al., July 18, 1950; 2,522,949, Jarman, Sept. 19, 1950; 2,686,390, Williams et al., Aug. 17, 1954.

Machines for Press Molding Hollow Glassware. Patent No. 2,903,824. Filed November 14, 1955. Issued September 15, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Robert R. Denman and Urban P. Trudeau.

The invention relates to machines for molding glassware. The machine as shown is of a type in which the neck portion of the hollow article is molded within a neck ring or mold separate from the body mold. The neck mold consists of partible sections held in closed position by fluid pressure. A charge of molten glass is introduced into a combined neck mold and parison mold. The blank is then given a hollow form and the neck portion of the article molded in the neck ring by a press plunger. The mold carriage is then rotated to bring the parison, while suspended from the neck mold, to the blowing station where the parison is enclosed in a finishing mold and blown to finished form. The next step rotation of the carriage brings the blown article, carried by the neck mold, to a take-out station where the neck mold is opened and the molded article removed.

There were 2 claims and 11 references cited in this patent.

Furnaces

Glass Conditioning Apparatus. Patent No. 2,913,509. Filed November 6, 1956. Issued November 17, 1959. No sheets of drawings; none reproduced. Assigned to Owens-Illinois Glass Company by Alfred D. Pinotti.

(*Continued on page* 302)

Research by Soviet Experts — Translated by Western Scientists

BORATE GLASSES

by L. Ya. Mazelev

Boron as an element has been known for a long time, but the role of its oxide in glass has been studied little. This book is based mainly on the results of investigating silicate and borosilicate glasses. The purpose of the author's work was a systematic study of the technology of glass melting, the processes and reactions of glass formation, the crystallization of glasses and the composition of the crystallization products, the physicochemical properties and their relation to the composition and structure of glass and methods of calculating these properties. This book is important for all those interested in the problems of the structure of glass.

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by A. S. Berezhnoi

Data accumulated on the physical chemistry of silicon and its binary systems are critically reviewed. The properties and descriptions of the crystal structures of silicon and all its binary compounds known at present are given in detail and the most important ways of using these substances in practical applications are indicated. Silicon carbide is treated in detail, as are silicon compounds of the transition metals. All sections have been provided with a historical outline and the basic literature is cited with each problem considered.

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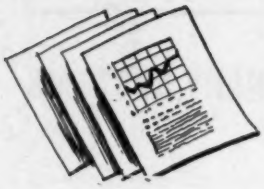


RESEARCH DIGEST

Batching Safeguards

● TODAY'S MODERN BATCH PLANT is an outstanding example of automation. In many installations, the entire process of unloading and storing of raw materials and the mixing and conveying of batch to the furnaces is completely automatic, and is often unattended by other than surveillance personnel. This movement toward complete automation has eliminated a great deal of chance for human error, but like a Frankenstein monster, man has created new problems through its use. Once a machine has made a mistake, it can seldom correct it on its own.

All glass container companies have developed their own inspection procedures which have eliminated literally all of the costly errors in raw materials handling and batch mixing. A paper by William Hanot (Northwestern Glass Company) in the March 1960 issue of the *Bulletin of the American Ceramic Society* relates a program which was initiated several years ago to insure quality from a mistake which otherwise might not be discovered until its effects became evident.

The system of checks begins with the unloading of the hopper bottom cars. The foreman and car unloader both check the shipping memo on the particular car, comparing car numbers to verify the material in the car that has been spotted at the siding. The material in the car is then checked visually by both men to further identify it.

Having been assured as to the identity of the material, they turn to the unloading equipment control board, where the proper key-operated switches will set the conveying machinery in motion. Both verify the proper bin into which the material will be stored, and choose the corresponding keys to operate the equipment. The keys are immediately returned to the cabinet, which is then locked. Only the foreman has the key to this cabinet.

This distribution system is so protected with electrical interlocks, that any mechanical or electrical failure will render the entire system inoperable.

A further unloading precaution prevents unloading cars of different materials into the same bin. When a car is switched from the unloading station, a photoelectric beam causes the distribution system to seek a neutral position, requiring the procedure of operating the key switches to be repeated.

A final check on the material in the designated bin is made by the batch plant operator. Before mixing the first batch of the day, and every fifth batch thereafter, he scoops a small amount of material from each operating vibratory feeder, and visually checks it against the appearance of the known material.

The weighing system incorporates a single weigh hopper and a Hardy scale. Changes to the settings on the potentiometer dials must be checked by a person other than the one who made the change. Minor weight corrections are made by the engineering department and checked by the batch plant operator. When a complete batch change is made, it is also checked by another member of the engineering department.

The operator observes the scale dial during the entire weighing cycle, and then adds the decolorizer, etc., upon completion of the weighing of the final material.

Periodically, the discharge of the batch from the mixer is observed to make sure the mixer is completely empty before it receives the next batch from the weigh hopper.

The operation of the weighing system is tested before mixing the first batch of the day, and after every fifth batch thereafter. This is done by lowering three 1500 lb. weights into a special structure over the weigh hopper. The scale is checked at 1500, 3000, and 4500 lbs.

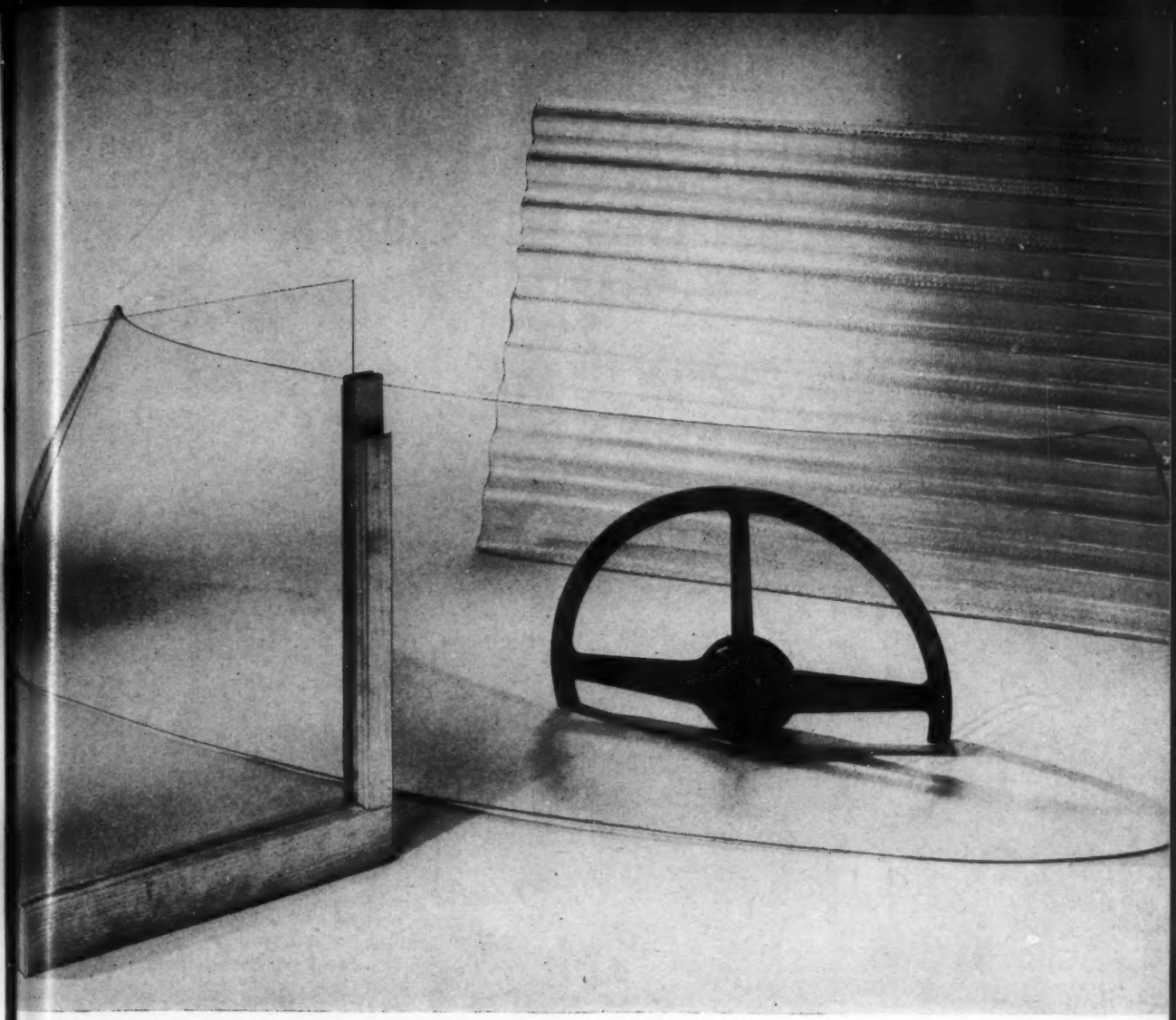
After all of the raw materials have been weighed out for the first batch of the day, they are allowed to remain in the scale hopper for five minutes. Thus any leakage in the discharge gate which could allow more than the indicated amount of material to be fed into the hopper is easily detected.

The accuracy of the batch scale is also checked monthly over the full range of the dial with 500 lb. tare weights. Daily and monthly tests are supplemented by a yearly check by the City's Bureau of Weights and Measures. The operators hold the weight of each ingredient of the batch to approximately $\pm$ ½ per cent of the posted figure.

After the batch has been discharged from the mixer into a surge hopper, it is delivered to a bucket elevator by a vibratory feeder, then discharged from the elevator through a spout to the storage bins. It is divided into four separate streams as it falls into these pie-shaped storage cells. These cells are 51 ft. high, and approximately 20 sq. ft. in area. The batch withdrawal is "flat"—there is absolutely no coning in either the charging or discharging of the bins.

At the bottom of the bins, it is again divided into four streams before it flows down a pipe to the blending feeders, and hence onto the conveyor belt. The cullet is

(*Continued on page* 301)



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CURRENT STATISTICAL POSITION OF GLASS

Employment in the glass industry during February, 1960, was as follows: *Flat Glass*: a preliminary figure of 32,100 for February, 1960 indicates a decrease of 0.3 per cent under the adjusted figure of 32,200 reported for January, 1960. *Glass and Glassware, Pressed and Blown*: An increase of 3.1 per cent is shown by the preliminary figure of 87,400 reported for February, 1960, when compared with the adjusted figure of 84,700 reported for January, 1960. *Glass Products Made of Purchased Glass*: the preliminary figure of 14,500 given for February, 1960 is equal to the adjusted figure of 14,500 reported for January, 1960.

Payrolls in the glass industry during February, 1960, were as follows: *Flat Glass*: a decrease of 1.8 per cent is shown in the preliminary $17,361,126.43 given for February, 1960, when compared with January's $17,691,465.68. *Glass and Glassware, Pressed and Blown*: an increase of 4.4 per cent is shown in the preliminary $34,492,378.54 given for February, 1960, when compared with the previous month's adjusted $33,012,108.75. *Glass Products Made of Purchased Glass*: a preliminary figure of $4,487,211.47 was reported for February, 1960. This is an increase of 0.7 per cent when compared with the adjusted figure of $4,452,655.80 for January, 1960.

Glass Container Production based on figures released by the Bureau of the Census, Industry Division, was 13,708,000 gross during March, 1960. This is an increase of 4.3 per cent over the previous month's production figure, 13,131,000 gross. During March, 1959, glass container production was 12,607,000 gross, or 8.0 per cent under the March, 1960, figure. At the end of the first three months of 1960, glass container manufacturers have produced a preliminary total of 39,594,000 gross. This is 18.9 per cent more than the 35,704,000 gross produced during the same period in 1959.

Glass Container Shipments during March, 1960, came to 13,097,000 gross, an increase of 14.2 per cent over February, 1960, which totaled 11,460,000 gross. Shipments during March, 1959, amounted to 12,215,000 gross, or 6.7 per cent less than March, 1960. At the end of the first three months of 1960, shipments have reached a preliminary total of 35,754,000 gross, which is 4.8 per cent more than the 34,103,000 gross shipped during the same period the previous year.

Stocks on hand at the end of March, 1960, came to 20,963,000 gross. This is 2.6 per cent more than the 20,423,000 gross on hand at the end of February, 1960, and 14.7 per cent more than the 18,275,000 gross on hand at the end of March, 1959.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Narrow Neck Containers

	March, 1960
Food	1,406,000
Medicinal and Health Supplies	1,466,000
Chemical, Household and Industrial	970,000
Toiletries and Cosmetics	928,000
Beverage, Returnable	848,000
Beverage, Non-returnable	109,000
Beer, Returnable	228,000
Beer, Non-returnable	933,000
Liquor	855,000
Wine	482,000
Sub-total (Narrow)	8,225,000

Wide Mouth Containers

Food	*3,620,000
Medicinal and Health Supplies	417,000
Chemical, Household and Industrial	167,000
Toiletries and Cosmetics	326,000
Dairy Products	123,000
Sub-total (Wide)	*4,662,000
Total Domestic	12,887,000
Export Shipments	210,000
TOTAL SHIPMENTS	*13,097,000

* This figure includes Fruit Jars, Jelly Glasses, and Packers' Tumblers.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production March 1960	Stocks March 1960
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,872,000	7,169,000
	Wide Mouth	*4,966,000	*6,693,000
Beverage, Returnable		1,080,000	2,499,000
Beverage, Non-returnable		112,000	269,000
Beer, Returnable		282,000	556,000
Beer, Non-returnable		981,000	1,096,000
Liquor		809,000	1,533,000
Wine		453,000	772,000
Dairy Products		153,000	376,000
TOTAL		*13,708,000	*20,963,000

* This figure includes Fruit Jars, Jelly Glasses, and Packers' Tumblers.

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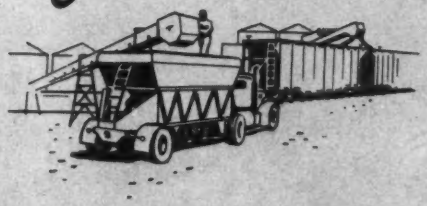
However you view your needs, you will find in West End a unique coordination of specialized services, extensive production facilities and product excellence essential to the prompt, efficient handling of individual requirements.

Flexible and efficient loading and shipping



Strategic location of West End plant permits fast, economical transport by rail or truck to any point in the West or throughout the nation. 30 minute in-and-out loading for bulk trucks at any hour of day or night through "serve yourself" delivery. Immediate shipment in West End's own leased hopper cars—ready at all times.

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NEW EQUIPMENT AND SUPPLIES

Dust Collector

High velocity dust collecting bench enables an operator to work from all sides of the grating surface thus eliminating down-time for repositioning the work. To place in operation the bench is set in place and wired to the starting switch. The fan and filter compartment are separate from the grating working surface but connected by a flat duct.

Wolverine Equipment Co., 31 Main St., Cambridge 42, Mass.

Glass Safety Coating

A plastic coating which can be applied to laboratory glass by spraying or painting is said to safeguard the chemist against broken glass and spilling of dangerous chemicals. The product can be used as a clamp ring coating, tong coating and to build up handles on spatulas.

Ace Glass Inc., Vineland, N. J.

Transparent Mirrors

For architectural applications where there is little difference in light intensity between the two areas involved. The twin-ground grey glass is coated with a transparent chrome alloy by thermal evaporation. A positive effectiveness is obtained with a four-to-one light ratio and the mirror will work satisfactorily with a two-to-one ratio. It is available in ¼" thickness and in any size up to 70 by 84 inches.

Libbey-Owens-Ford Glass Co., 811 Madison Ave., Toledo 3, O.

A.C. Speed Drives

Integral-unit, adjustable-speed a.c. drives that are rated from ¼ to 100 hp. The output speed is monitored with built-in tachometer and automatically corrected regardless of any changes in load. No brushes, commutators, or slip rings to maintain. The electromagnetic drive is designed to apply adjustable speed power to conveyors, fans and pumps, winders and metal slitting and forming machines. Drives of 700 hp with liquid cooling and a separate motor mounted on a bedplate are also offered.

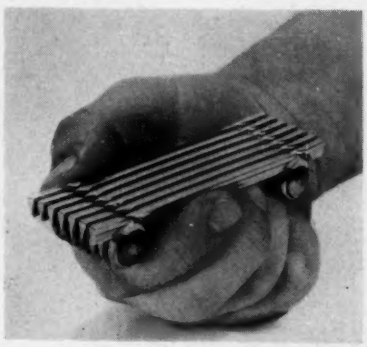
Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

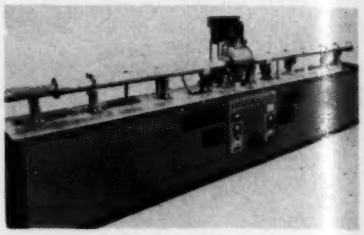
Wedge-Wire Screen

Stainless and carbon steel screens furnished in rectangular, oblique angled, round and oval beds with sharp or round bends. Conical segments, cylindrical troughs and other special shapes are also available. Screens can be used to sift, dewater, size, wash, filter and screen chemical and food products and minerals.

Slanting, tapered, flanged and diamond profiles are included and slit widths down to 0.0002 inches can be furnished. Spacing lugs provide rigidity in the screen, prevent lateral deflection and preserve uniform slit spacing.

Cross Perforated Metals Plant, National-Standard Co., Carbondale, Pa.





Vacuum Furnace

A continuous firing vacuum furnace for mass volume production features an indexing of the work boats from stage to stage, including the heat zone. The firing chamber is below atmospheric pressure and can be maintained as low as .01 micron continuously while the work boats are moving from stage to stage. Normal power consumption is 30 kw.

Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J.

CATALOGS RECEIVED

Wire cloth. (102 pages) Revised industrial woven wire cloth catalog. Additions made in metals and alloys, fabrication, and reference data sections. Publication describes industrial wire cloth made in nine basic weaves in a wide variety of metals and alloys.

THE CAMBRIDGE WIRE CLOTH CO., Cambridge, Md.

Cobalt. Research report on the influence of cobalt additions on the structure and the mechanical and chemical properties of ferritic and austenitic stainless steels. Stainless steels investigated contained 17 and 27 per cent chromium and nickel contents of 0, 2, and 9½ per cent. Cobalt additions ranged from 1.5 to 10 per cent. Tests confirmed that cobalt increases corrosion resistance in acid solutions; after appropriate heat treatments, the cobalt-alloyed steels showed diminished susceptibility to intergranular corrosion.

COBALT INFORMATION CENTER, C/O BATTELLE MEMORIAL INSTITUTE 505 King Ave., Columbus 1, O.

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NEW BOOKS

HIGH TEMPERATURE MATERIALS. By *R. F. Hehemann and G. Mervin Ault.* J. Wiley & Sons Inc., publishers.

Nickel and cobalt base alloys are now used for high temperature applications, from 1500 to 1800°F. What are these alloys? How do they derive their strength from the precipitation of microconstituents? What is the importance of vacuum melting on their properties? And how will the alloys of the future be made for applications at higher and higher temperatures?

This excellent book gives the answers to all these questions, in 34 papers presented by 51 of the experts of high temperature metallurgy, at the April, 1957, conference of the Metallurgical Society of the A. I. M. M. E. in Cleveland.

In can be used as a reference book, since it contains data on compositions and properties of most of the superalloys, except the latest ones. But rather than a manual on how these alloys are made and utilized, it is a summary of the most recent findings of research on the principles involved in high temperature properties.

Designing new alloys starts with the application of these principles to more refractory base materials. However, the study of the influence of alloying elements is not well known and must be done all over.

Unconventional approaches such as dispersion hardening, internal oxidation and cermets are also discussed.

The book is divided into seven parts:

Part I: contains data on nickel and cobalt base alloys and explains the principles of precipitation hardening.

Part II: mainly devoted to cemented carbides: contains some data on intermetallic compounds.

Part III: reviews the progress made in the study of the new refractory metals: chromium, molybdenum, tantalum, columbium (niobium), rhenium and tungsten. These metals are very promising for future applications; unfortunately all of them have drawbacks: chromium has a very poor room temperature ductility, and all the others, as pure metals, have a very poor oxidation resistance. However, intensive research is carried out in this field, especially on the effect of alloying elements, and new alloys with better properties are being developed.

Part IV: a short review of the particle dispersion strengthening process, first used in the Swiss SAP aluminum alloy. A very fine dispersion of refractory oxides in the matrix improves greatly the high temperature properties. This principle has been applied to copper, nickel and titanium matrices.

Part V: deals with the effect of vacuum induction melting and consumable electrode melting on the properties of alloys.

Part VI: studies the effect of testing environment on the high temperature properties of some alloys, especially a comparison of tests carried out in air, argon, helium or sodium hydroxide environment.

Part VII: reports the findings on the study of oxidation resistance of several metals, and the effect of alloying elements to improve the oxidation resistance.

This book will bring up to date the metallurgist who is interested in high temperature materials. It is an excellent reference book containing a wealth of information.

—Pierre P. Turillon, research metallurgist, Metals Division, Kelsey-Hayes Company.

MATERIALS AND TECHNIQUES FOR ELECTRON TUBES, by Walter H. Kohl. Published by Reinhold Publishing Corp; 638 pages. $16.50.

Not since John Strong's "Procedure in Experimental Physics" has a text been of greater value to the scientific worker. The elaborate coverage of reference material, for each subject, exemplifies Mr. Kohl's thorough preparation in this work. Certainly this is a bible for those in tube research and component parts production.

(*Continued on page* 302)

As a special service to readers of THE GLASS INDUSTRY, a Book Department has been established. You may now order all technical books on glass and related fields by writing to:

BOOK DEPARTMENT

THE GLASS INDUSTRY

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Glass Engineering Handbook . . . $10.00
By E. B. Shand

Modern Glass Practice 7.00
By S. R. Scholes

Properties of Glass 16.50
(Second Edition)
By George W. Morey

Proceedings of the 4th International Commission on Glass 8.00

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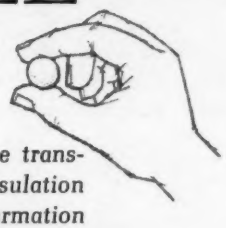
MIRACLE

of fiber glass



This glass "marble" is ready to be transformed into miles of fiber for insulation material. To ensure that this transformation is routine, continuous, and profitable, the manufacturer entrusts the preliminary glass annealing to Surface Combustion lehrs.

Surface delivers the necessary time-temperature cycles with remarkable precision, using either gas or electric heat with unusually high rates of air recirculation and complete zone control. These, plus Surface modular construction, are good reasons for Surface's leadership in glass processing equipment.

SURFACE COMBUSTION

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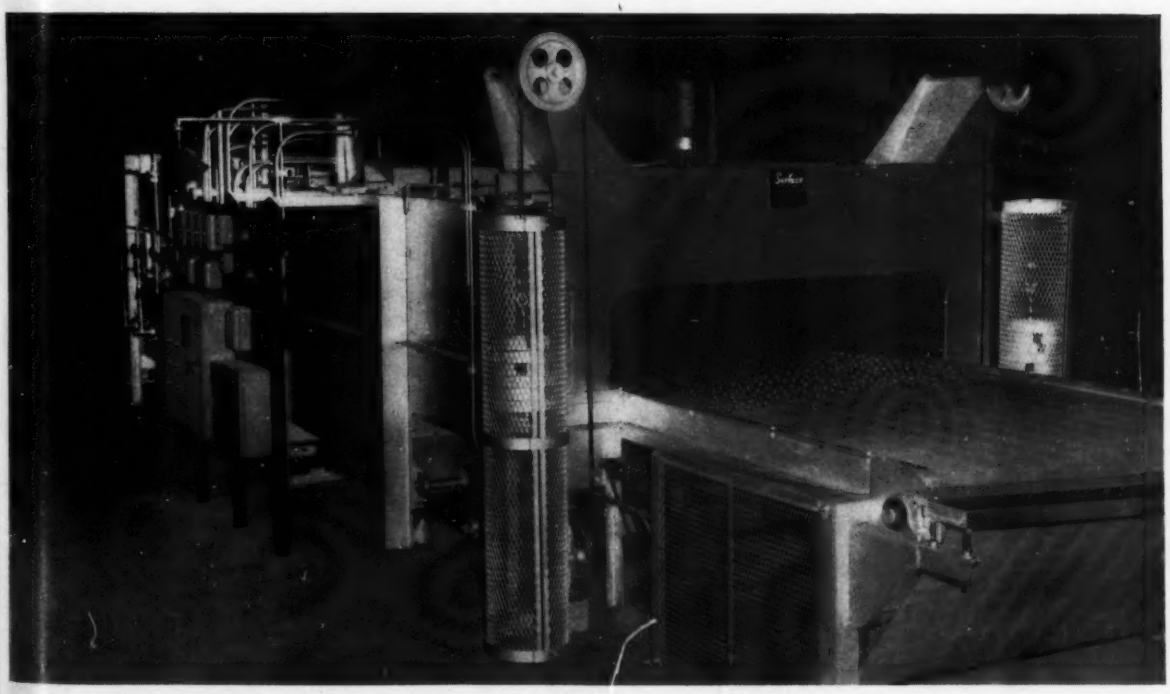


REPLACEMENT OF SODA BY LITHIA

(*Continued from page* 263)

Lower operating temperatures and the obvious concomitant savings should result from the more fluid lithia glasses.

In general, lower coefficient of expansion means improved resistance to thermal shock, but in some cases may require compensations such as in the sealing of two glasses.

The whiter color of lithia glasses should make for better sales appeal.

The improved light transmission of the lithia glasses should find application in the illuminating field.

The economic benefits implied above can best be determined by plant trial and careful study of complete cost data.

Table IV

REFLECTANCE OF OPAL GLASS

Composition	Color of Filter	Reflectance of Standard	Sample Thickness	Average Reflectance of Sample
A	Green	71.6	0.117 in.*	80.8
B	"	"	0.129 in.*	76.9
C	"	"	0.124 in.*	77.6
A	"	"	0.205 in.*	86.1
B	"	"	0.207 in.*	83.7
C	"	"	0.193 in.*	81.9
A	"	"	0.322 in.	87.7
B	"	"	0.336 in.	86.4
C	"	"	0.317 in.	86.0
A	"	"	0.544 in.*	88.7
B	"	"	0.570 in.*	87.9
C	"	"	0.635 in.*	88.0
A	"	"	0.661 in.	88.6
B	"	"	0.699 in.	87.5
C	"	"	0.759 in.	88.1
A	"	"	0.749 in.	89.0
B	"	"	0.777 in.	88.2
C	"	"	0.828 in.	87.9
A	"	"	0.866 in.	89.0
B	"	"	0.896 in.	88.2
C	"	"	0.952 in.	87.9

* Single discs. All other thicknesses are combinations of these discs.

Table V

REFLECTANCE OF ZINC ALABASTER GLASS

Composition	Color of Filter	Reflectance of Standard	Sample Thickness	Average Reflectance of Sample
D	Green	85.1	0.129 in.*	59.8
E	"	"	0.129 in.*	60.0
F	"	"	0.132 in.*	56.0
D	"	"	0.195 in.*	64.9
E	"	"	0.215 in.*	65.3
F	"	"	0.210 in.*	64.5
D	"	"	0.324 in.	71.5
E	"	"	0.344 in.	71.6
F	"	"	0.342 in.	71.1
D	"	"	0.640 in.*	74.9
E	"	"	0.650 in.*	74.7
F	"	"	0.635 in.*	74.2
D	"	"	0.769 in.	75.5
E	"	"	0.779 in.	75.5
F	"	"	0.767 in.	74.6
D	"	"	0.835 in.	75.3
E	"	"	0.865 in.	75.8
F	"	"	0.845 in.	74.4
D	"	"	0.964 in.	75.5
E	"	"	0.994 in.	75.8
F	"	"	0.977 in.	74.8

* Single discs. All other thicknesses are combinations of these discs.

Table VI

SUMMARY OF LIGHT SCATTERING PROPERTIES OF OPAL AND ALABASTER GLASSES

Composition	Sample Thickness	Reflectance*	Reflectivity*	Coefficient of Scatter**	Opacity**
A	0.15 in.	83.5	88.7	40.7	96.0
B	"	80.0	88.0	30.0	93.0
C	"	80.0	88.0	30.0	93.0
A	0.20 in.	85.6	88.7	41.0	98.0
B	"	83.3	88.0	31.0	96.0
C	"	82.7	88.0	29.5	96.0
A	0.25 in.	87.0	88.7	40.4	99.0
B	"	85.0	88.0	31.2	98.0
C	"	84.5	88.0	30.0	97.6
A	0.30 in.	87.7	88.7	41.6	99.0
B	"	86.0	88.0	30.7	99.0
C	"	85.6	88.0	29.7	98.5
D	0.15 in.	61.5	75.5	11.9	78.6
E	"	61.5	75.5	11.9	78.6
F	"	57.8	74.5	10.5	75.8
D	0.20 in.	65.2	75.5	11.7	85.2
E	"	65.2	75.5	11.7	85.2
F	"	63.0	74.5	10.5	83.0
D	0.25 in.	68.3	75.5	11.8	90.0
E	"	68.0	75.5	11.4	89.8
F	"	67.0	74.5	11.2	89.2
D	0.30 in.	70.7	75.5	11.7	93.5
E	"	70.0	75.5	10.9	92.5
F	"	69.7	74.5	11.3	93.4

* Read from Figure 4 for indicated sample thickness.
** Read from chart of Kubelka and Munk in Porcelain Enamel Institute Bulletin.

REFERENCES

1. H. H. Blau in *Modern Glass Practise* by S. R. Scholes, page 219. Revised Edition (1952).
2. "Reflectance Test For Opaque White Porcelain Enamels", Technical Research Section Educational Bureau, Porcelain Enamel Institute, Inc. (1936).

GLASS FOR FISSION PRODUCTS

(*Continued from page* 267)

counting disc which was then counted in a β^- proportional counter. The count in the effluent was related to a weight of glass removed as described previously. In Fig. 2 the corrosion rate measured in this manner is plotted as a function of time. The shape of the curve obtained is fairly typical of that obtained with all samples, although some curves show unexplained fluctuations.

Table III

COMPOSITION OF GLASS

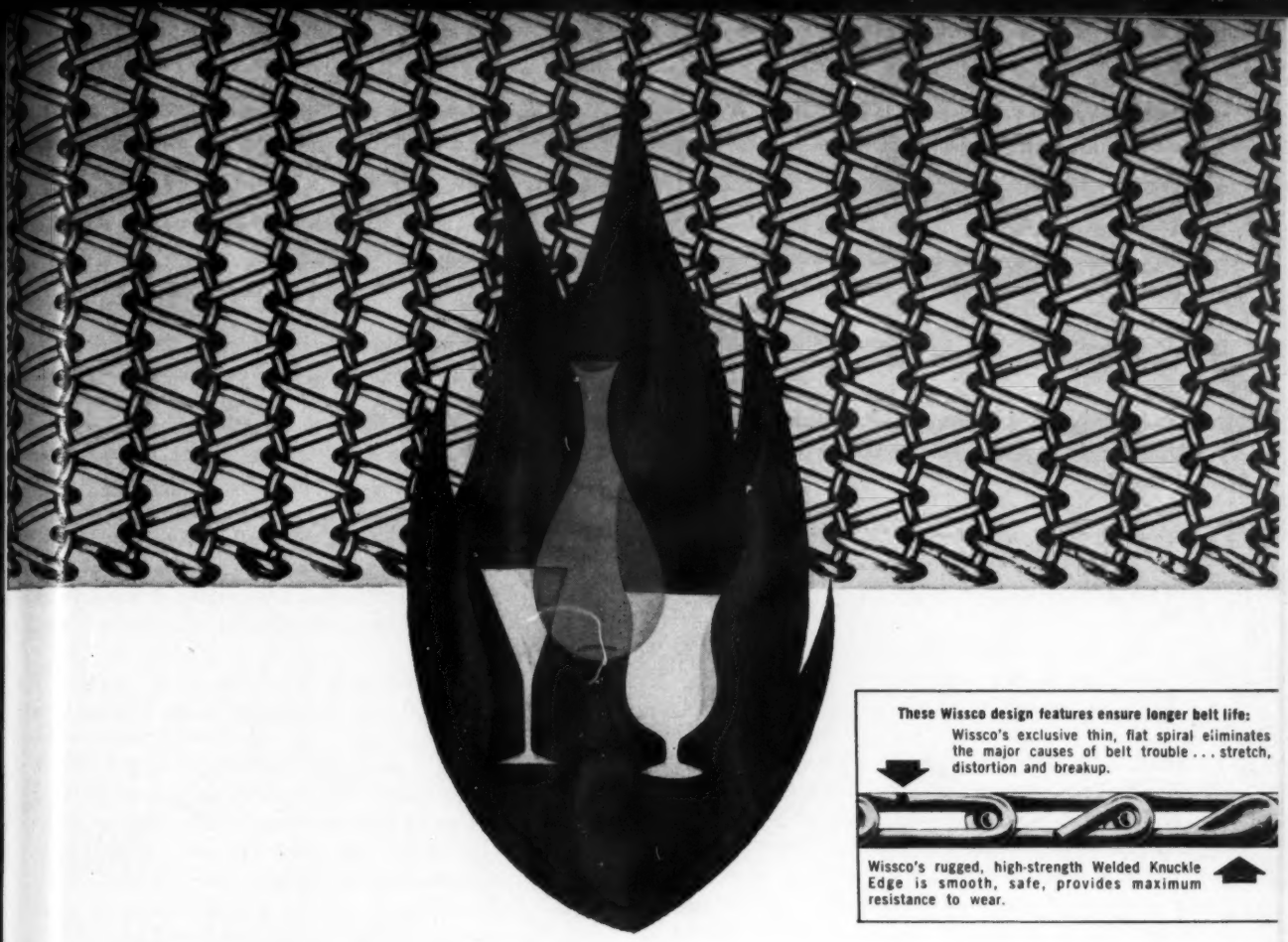
SiO_2	47.7	weight %
Al_2O_3	19.2	
CaO	14.6	
Na_2O	10.3	
K_2O	3.7	
Fe_2O_3	2.7	
Cr_2O_3	0.6	
NiO	0.2	
U_3O_8	0.9	
MgO	0.1	

Leaching in Cold, Slowly-flowing, Ground Water

In a disposal of radioactive glass, the water that contacts the glass will be ground water rather than distilled water. A single test similar to the above was done with ground water and there was no significant difference in the leaching rate.

Leaching in Warm, Slowly-flowing, Distilled Water

As was pointed out before, in certain conditions the



These Wissco design features ensure longer belt life:

Wissco's exclusive thin, flat spiral eliminates the major causes of belt trouble . . . stretch, distortion and breakup.

Wissco's rugged, high-strength Welded Knuckle Edge is smooth, safe, provides maximum resistance to wear.

Where there's ware . . . there's

CF&I-Wissco Lehr Belts

Where processing operations require heat treatment of glass, china and ceramic ware, you'll find Wissco Lehr Belts. Each year they receive increasing endorsements because of their operating dependability—a dependability that's one of the meanings behind the Image of CF&I.

Every Wissco Lehr Belt is expertly engineered to assure long service life with a minimum of maintenance. Leading glass and ceramics manufacturers tell us they get greater operating economy with Wissco Lehr Belts, because of these advantages:

- **Uniform circulation of heat** — Wissco's open mesh construction allows heat and gases to flow freely on all sides, including the underside, of the ware. And as the speed of the belt is constant, each piece of ware gets exactly the same treatment.
- **Minimized checking of the ware** — Metal belts have low thermal capacity which prevents excessive heat from being imparted to the products at the points of contact.
- **Smooth discharge of products** — A metal belt has a low adhesion factor, which permits easy removal of the ware.
- **Accident-proof ride** — Wissco's thin, flat spiral provides a smooth supporting surface for the ware. Even tall pieces with small bottoms ride safely through annealing and decorating lehrs without tipping.

Wissco Lehr Belts are available in Balanced Spiral and Rod Reinforced weaves. They are made from steel or special alloys to withstand temperatures up to 2100°F. For the complete story on Wissco Lehr Belts, contact the CF&I office nearest you.

WISSCO BELTS
THE COLORADO FUEL AND IRON CORPORATION

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In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Denver and Oakland
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7616

heat generated by fission-product decay can raise the temperature of the glass. The effect of leaching by warm water is therefore of interest. Preliminary results of a test designed to show this effect are given in Fig. 3. The experimental method was unchanged from that used for the cold water tests except that the system was heated to 40° and 60°C at the times indicated on the Figure.

Effect of Devitrification on Leaching

There is adequate power from fission-product decay in short-cooled, concentrated wastes to raise the glass temperature to a very high level if the storage geometry is appropriate. In such a case devitrification of the glass may result during the long cooling period. The consequence of devitrification is an increased leaching rate if the glass is subsequently exposed to water. The extent of the increase may be seen by comparing the curves in Fig. 4 and Fig. 2.

The rate of devitrification was measured for an inactive glass of the composition given in Table 3. The data were represented by the equation

$$w = 9.5 \times 10^{-5}\ e^{-0.01T}$$

where w is the crystal growth rate in microns/minute and T is the temperature in °C for T between 850 and 1100°C. At lower temperature the growth rate was considerably lower than that predicted by the equation. The data given in Fig. 4 were obtained from leaching a specimen of glass containing fission products and devitrified to a depth of 75 microns as estimated from the equation.

Effect of Irradiation on Leaching

Two glass samples, one inactive and the other containing fission products, were irradiated with Cobalt-60 gamma rays to estimated energy inputs of 1.3 and 1.7 x 10^{12} erg/g, respectively. The inactive specimen was examined visually at intervals during exposure. No effects were noted. The radioactive sample was removed and subjected to a leaching test in cold, slow-flowing distilled water. The leaching rate did not differ significantly from that of an unirradiated control specimen.

Effect of Cooling Rate

Glass samples prepared identically in all respects except in method of cooling exhibited differences in durability. In the usual method of preparation the glass was cooled slowly at the natural cooling rate of the furnace used. This was about two hours from 1350°C to 900°C and a further 14 hours to 200°C. Samples cooled from 1350°C to room temperature in one hour were attacked by water at a significantly slower rate. The magnitude of the effect may be seen by comparing the curves in Fig. 5 and Fig. 2.

Effect of Interrupted Water Contact

At infrequent intervals it has been necessary to remove a sample of glass from the test system to store it in air. The samples have always been picked up carefully with rubber-tipped tongs although there was some possibility of surface damage. On resuming the leaching test the rate of release of activity has shown a marked increase over that prevailing at the time of interruption. The results obtained in a typical interrupted test on a rapidly cooled specimen are given in Fig. 5.

Discussion of Results

The leaching-rate curves presented in this report, and the results of many other tests, show that it is relatively simple to produce a glass containing fission products that will release them to water at a rate corresponding to a uniform corrosion of 10^{-7} to 10^{-8} g/cm²-day after six months' to one year's immersion. It is not known whether the curves, which show a continuing decline in rate, can be extrapolated or whether they will become asymtotic after a few years. This question is of little consequence because the first few months of water attack releases such a high proportion of the eventual total release.

It has been calculated[2] for a continuing disposal of a specific waste that at equilibrium in the disposal area approximately one part in 10^4 of the total fission products put into the glass would be freed from it by leaching into cold water. This calculation was made using a typical leaching rate curve assumed to become asymtotic to 10^{-8} g/cm²-day after one year. Most of the fission products outside the glass are released during the first year's leaching of any specific piece of glass. To reduce the overall release it is necessary, therefore, to reduce the initial leaching rate. The glasses studied to date have given little evidence that a significant reduction (a factor of 10 to 100) can be achieved by altering the composition of the glass.

The two most obvious methods of reducing the initial rate are by coating the active glass with a thin layer of inactive glass, or by preleaching. The first method has been rejected, temporarily at least, on the grounds of added complexity. The second method is rejected on the combined grounds that it would produce a secondary liquid waste stream, and that unless it were done in situ it might not have the required effect (Fig. 5).

Although fast cooling appears to develop a more resistant surface on the glass, it would seem likely that decreasing the size of the glass pieces so that they could be cooled and annealed adequately in the short time would result in sufficient area increase to obviate the effect of fast cooling.

The effect of devitrification on leaching rate is large enough that it should be specified that glass must be stored well below the devitrification temperature. The results do indicate that even if some devitrification occurred no catastrophic release of fission products would ensue.

Leaching in warm water results in more rapid release of fission products and should be avoided. These experiments have not proceeded far enough to permit a critical assessment of the results. The curve obtained

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Volume I of the Handbook of Glass Manufacture was originally published in 1953 by the Ogden Publishing Company. Uninterrupted demand for the book necessitated a second printing in 1957 in order to meet the needs of all those concerned with glass manufacture, technology and engineering. Both the first and second printing of Volume I have been sold out.

As a supplement to the first edition, Volume II of the Handbook of Glass Manufacture will be published on August 15, 1960, and will again be edited by Dr. Fay V. Tooley, Professor of Glass Technology, Department of Ceramic Engineering, University of Illinois.

CONTENTS . . .

Chemical and Instrumental Analysis of Glass
Francis Glaze, Consultant
John Time, Owens-Corning Fiberglas Corp.

Optical Properties of Glass: Effects of Radiation on Glass
Norbert J. Kreidl, Bausch and Lomb Optical Co.

Scientific Glass Blowing
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Flat Glass Manufacturing Processes
Roy G. Ehman, Pennsylvania State University

The Quality Control Chart
Ronald Wiley, Owens-Corning Fiberglas Corp.

Electric Melting of Glass
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thus far is somewhat distorted by the method used in testing but is obviously peculiar in shape.

The effect of interrupting water contact is shown to be deleterious but it has not yet been determined whether this is due to mechanical disruption of the surface because of handling with consequent exposure of fresh surface or to continuing dissolution into water contained in the surface of the glass. If surface disruption is the cause there will be no problem in an undisturbed disposal.

Irradiation to an energy input of 1.7×10^{12} erg/g had no effect on the leaching rate of the glass. It is estimated that the maximum energy input to glass containing power-reactor wastes will be 4×10^{12} erg/g. The experiment is being continued to 4 to 5×10^{12} erg/g.

Considering the various properties of the glass, the following restrictions must be placed on its disposal until such time as further information becomes available.

1. If fission-product release is to be entirely prevented, the glass must be stored dry.
2. In case of future water penetration of the dry storage, the glass should be stored at a temperature well below that at which devitrification is significant, otherwise high leaching rates may result.

With these restrictions it is virtually certain that fission products contained in glass can be stored safely for a very long time in a dry container such as a concrete vault or a cavern in salt. After a few hundred years there is no significant amount of fission products left, and the quantity and the chemical nature of the transuranics is such that minor dispersion of these will be of no consequence.

On the assumption that it will be less expensive just to bury the glass directly in the ground, this method is being investigated. The principal problems foreseen relate to leaching and to the fate of the leached fission products in soil.

Heat effects can be obviated by either aging the fission products in solution prior to incorporation into glass and burial or by adequate dispersion of the glass so that the heat is removed by conduction. A test of the disposal of fission products in glass buried below the water table (water flow rate of five inches/day) has given encouraging results. No fission products have been found in either the soil or the ground water at a distance of one foot from the glass in the direction of water flow after 15 months. This test is proceeding, and a second experiment of enhanced sensitivity is being planned.

Summary

A method of incorporating fission products into glass has been devised and demonstrated. The glass immobilizes the fission products to a high degree even if it is immersed in water. The rate of leaching is increased if the temperature increases or if the glass devitrifies, but both these effects can be prevented. Gamma radiation up to 1.7×10^{12} erg/g of glass had no effect on leaching.

The glass can be stored in a dry location with negligible risk of dispersing fission products. The safety of burying the glass directly into the ground is being investigated, as the method is perhaps less expensive although it will require an exclusion area.

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PRESSED GLASS

(*Continued from page* 273)

to the Boston and Sandwich Glass Company registered a patent for producing handled beer-mugs. Andrew H. Baggs, assignor to La Belle Glass Company of Bridgeport, Ohio, patented a mold for making stemmed glassware on December 2, 1873, whereby the annular mold-mark was artfully concealed in the fluted design. The handsome form of the goblet shows an improvement in design for such pressed wares. A patent for producing pressed, footed glassware with a hermetically sealed air-bubble within its stem (Fig. 4) was registered November 3, 1874, by John H. Hobbs, William Leighton, Jr., and Charles W. Brockunier of Hobbs, Brockunier & Company. The production of such articles, heretofore only possible in hand-blown wares, marks a great advance in the pressed glass industry.

On May 19, 1891, Louis Schaub of Wheeling, West Virginia patented an improvement on the technique whereby the hand-tooling necessary in the production of the Hobbs-Leighton-Brockunier stemware was obviated.

The production of oval-shaped dishes supported upon legs or standards was the subject of a patent issued to Alonzo E. Young of the Boston Silver-Glass Company on May 11, 1869. Mr. Young claimed in his specifications that prior to his invention only round or rectangular dishes were press-molded with a central pillar, or supporting-standard. The oval-shaped compotes and footed dishes were handsome productions made in the Boston Silver-Glass Company's several pressed tableware designs.

Oil lamps were another important item produced by most of the factories engaged in the manufacture of press-molded glassware. One of the first patents we were able to find covering their production was registered by Joseph Magoun on September 24, 1847. The illustrations show a lamp-font in the New England Glass Company's "Loop" pattern. The font emerged from the mold looking very much like the cup of a goblet. After it was taken from the mold the upper part was heated and contracted into the shape required to receive the metallic collar of the wick tubes. We illustrate a Design Patent for a similar oil lamp issued to Patrick Slane March 26, 1845, to give some idea of the physical appearance of such lamps.

On August 19, 1856 Henry W. Adams patented a means for producing fountain lamps in their entirety. Prior to Adams' patent many manufacturers considered

their production, "if not impossible, an operation of very great difficulty." The new mold rendered the operation of making such lamps "perfectly simple and easy."

A mold for producing twin-fountain oil lamps (Fig. 5) by both a pressing and a blowing operation was patented July 14, 1870, by Daniel C. Ripley. Ripley's patent provided for the stem, stock, or center-piece to be pressed in a mold provided with two or more connecting cavities into which two or more glass blowers blew, simultaneously, a glass lamp-bowl or font. In a later patent Ripley modified the shape of the pressed central support or stem to form a depression which was utilized as a match-safe.

William T. Gillinder, of Gillinder & Bennett Company, Philadelphia, patented a new kind of blow pipe (Fig. 6) on December 5, 1865. Actually, the tool was a combination plunger, blow pipe and snap-clamp which enabled the glass worker to press a blank and blow it out into a bulbous shape all in one swift operation. The tool was specially well adapted for fashioning articles with press-molded handles.

Prior to Gillinder's invention a glass vessel requiring handles or similar protuberances, such as pitchers, mugs, etc., was first cast or pressed in a mold provided with a plunger which was subsequently withdrawn from the molded vessel. Thereafter it had been necessary to rotate the inner and/or outer surface of the pressed blank in direct contact with a suitable hand-tool to expand or shape and form it properly. The handle was afterwards formed and attached to the article.

On March 17, 1868, Daniel C. Ripley patented a method for pressing the top of a glass pitcher in a mold and thereafter attach it to a blown body with cement. James S. and Thomas B. Atterbury patented an improvement on the Gillinder method June 17, 1873. The article was pressed and blown to full size all in the same mold. Phillip Arbogast patented a similar method July 11, 1882. Hollow-wares with handles and feet were pressed and blown in the same mold in a method patented June 29, 1886 by Henry C. Schrader of Wheeling, West Virginia.

Three patents were issued to Daniel C. Ripley (June 7, 1887, August 25, 1891, and June 21, 1892) for improvements in the production of fancy pressed and blown glassware. On May 18, 1897, two patents were issued to Julius Proeger covering his processes for manufacturing pressed and blown articles of glass. Gillinder's important contribution to the industry can only be fully realized when we consider that the basic idea he patented in 1865 germinated and developed in later years into those multi-arm machines capable of producing thousands of pressed and blown articles of glass in a single day.

Some very artistic glasswares were produced in the last half of the nineteenth century utilizing pressed blanks

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welded to a blown body. The first of these methods were patented by James and Thomas Atterbury February 11, 1862, March 4, 1862 and June 3, 1862. In each of the patents the main portion of the article was pressed in a mold to produce a raised ornamental design on the blank. A bulb of plastic glass was inserted into the mold and expanded until it adhered to the pressed ornamental blank in the bottom of the mold. The article was then blown to full size in the same mold. Thomas Atterbury produced a ware, entirely by pressing, that resembled somewhat the cameo technique (Fig. 7). He first pressed the main portion of the article using a ring-plate to reserve a space in the blank into which he also cast an ornamental design in glass of another color. According to Atterbury the appearance of such articles "will be very similar to, and look quite as well as, a cameo."

On September 29, 1874, Benjamin Bakewell, Jr. patented his method for a similar ware which was known as "Double Glass." William L. Libbey of the New England Glass Company patented a method for pressing and blowing a ware "having the general appearance and character of the well-known Portland vase" on November 9, 1880.

Several other interesting pressed wares made to simulate more expensive glass techniques were patented in the nineteenth century. On October 17, 1865, the Atterbury brothers patented a means for producing pseudo-cameo incrustations. Their patent enumerations illustrated a bust of Lincoln (Fig. 8) impressed in the base of a heavy beer mug and painted with white enamel. When viewed from the top it had all the physical attributes of the crystallo ceramie technique. An even better idea along these same lines was patented October 2, 1865 by Thomas R. Hartell of Philadelphia, Pennsylvania. Mr. Hartell pressed his blanks in figured molds, and after they had annealed he filled the depressions with common plaster of Paris. The pseudo-cameo incrustations had all the appearances of the original technique with far less cost to the manufacturer.

Lithophane lamp-shades were press molded by Hobbs, Brockunier & Company according to a method patented by Messrs. Hobbs, Brockunier and Leighton on April 25, 1871. The manufacturers squeezed "hot-pressed porcelain" (opal glass) in a mold to produce the uneven figured surface necessary to a lithophane. The thick and thin portions of the design produced scenic pictures when the lamp was lighted (Fig. 9).

Pressed ornamental tiles were patented by Jonathan Haley of Ravenna and Fostoria, Ohio, on May 4, 1886, and October 25, 1892. In the first patent Haley produced a shaded design in the tile by reheating the sensitive metal until the thinner portions became colorless. In the second patent (Fig. 10) he impressed an ornamental design on the back of the tile in varying depths thereby producing a deeper color in the thicker portions of the tile. In a patent issued to him in England on January 16, 1888, Haley backed the figured glass tile with plaster of Paris to produce a "silvered effect" or

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a "gold effect"; the color of the glass determined the color effect obtained.

The pressed glass industry met the needs of the nation in a host of household articles manufactured during the nineteenth century: caster holders and bottles, spoon racks, stemmed compotes, dishes and fancy baskets, syrup pitchers, tiered flower and fruit stands, match-safes, door blocks, clock cases, glass signs, cups with mustache-guards and tubular glass fittings for chandeliers and gas-lights (Figs. 11-16). Finally, on September 18, 1860, George W. Scollay of St. Louis, Missouri, registered the first of many patents for a pressed-glass coffin. The industry had indeed met our ultimate need.

ELECTRIC BOOSTING AND BUBBLING

(Continued from page 275)

the glass in the lower levels is too cold for good glass melting practice. The homogeneity of the glass is often poor, and the stone loss is high. In such cases, a bubbler installation is an ideal solution because it has such a low operating cost.

In a dark green glass furnace where the convection currents are stagnant, a bubbler installation can be expected to stimulate the convection currents until they are similar to those in a flint tank. This also means that the temperature in the lower levels of glass will be raised to the temperatures normally expected in a white flint glass tank.

This has been proven recently by means of a new development, the Glass Bath Pyrometer. This pyrometer consists of a closed-end target tube which is mounted in a hole in the sidewall of the furnace, so that the temperature of the glass below the surface can be measured. This measurement can be taken with a hand pyrometer or can be measured by means of a radiation head connected to a recording instrument.

In one case in light green glass where there was considerable trouble with cords, the temperature of the lower levels of glass was found to be 1850°F. By means of a bubbling installation, this temperature was brought up to 2260°F, which was considered more normal. The cord trouble was eliminated, and the stone loss was reduced from an average of 4 per cent down to less than 1 per cent.

In another furnace melting dark green glass, the temperature in the lower levels was found to be 2030°F. After the installation of bubbling, the temperature of the lower levels was brought up to 2210°F. An electric booster will be installed to increase further this temperature and to increase the total output.

The specific improvements due to bubbling can be divided into the following headings:

1. Improving Homogeneity

The most powerful effect of bubbling is the improvement of homogeneity, in two ways. First, the bubbling stimulates the main convection current. This is helpful because there are variations in composition from one batch pile to another, and the main convection current mixes glass which is melted from one batch pile with

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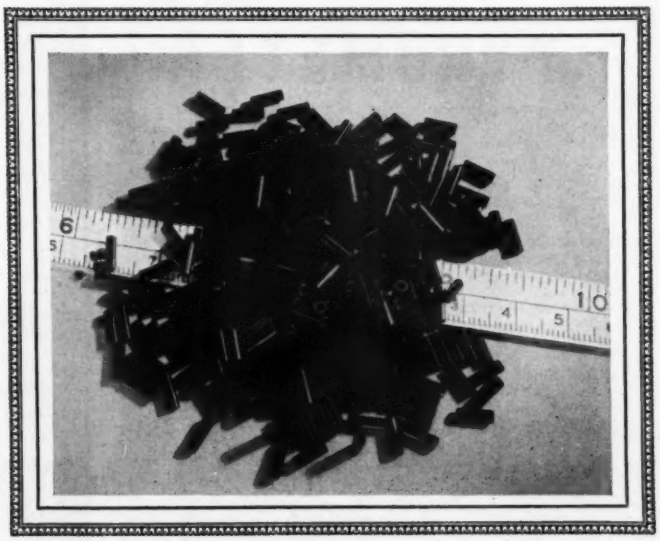

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that which is melted from the other batch piles.

Second, the bubbling system improves homogeneity by introducing local turbulence into the flow of glass in the tank. In this way, it resembles the action of local turbulence around electrodes, as discussed earlier. This local turbulence mixing is beneficial for eliminating cords. When a bubbler system is operating, it is reasonable to expect that glass will be brought up to B plus grade of homogeneity. This grade works very well on the machines, and gives strong bottles in service.

It should be mentioned that bubbler systems are useful in white flint tanks as well. They prevent disturbances of production due to cords, which occasionally happen in most furnaces.

2. Reducing Fuel Consumption

In many furnaces, our bubbling system is able to reduce fuel consumption due to the fact that cold, dark glass from the bottom of the furnace is brought to the surface where it acts as an efficient absorber of heat from the flames. The decrease to be expected in fuel consumption per ton of glass is variable from furnace to furnace, but can be as high as 6 per cent.

3. Reducing the Furnace Temperatures

Reduction in the firing temperatures is made possible by the same action as described in the preceding paragraph, whereby the cold, dark glass is brought to the surface to absorb the heat readily. Thus it is not necessary to maintain the upper structure of the furnace at so high a temperature as formerly to transfer the same number of heat units to the glass. The decrease of firing temperatures can be as much as 55°F.

4. Decrease in Stone Losses

This factor is particularly important in colored glasses. Such glasses often have a higher stone loss than white flint glass. This higher loss is understood to be due to the reduced temperature of the lower layers of glass, so that stones from the batch and from the refractories can travel along in the viscous layer without becoming hot enough to dissolve. The Penelectro Bubbling System stimulates the convection current so that such stones are not permitted to remain on the bottom. They come to the surface where they are heated and mostly dissolved. The continuous stone loss of a regular dark green glass furnace could be as much as 7 per cent. When the bubbling system has been in operation, the stone loss should decrease to under 1 per cent.

5. Increasing Production

Our bubbling system has been able to increase the maximum output from furnaces. If the furnace is melting white flint glass, with a well developed convection current, with a mirror-surface near the bridgewall, the increase in output is small. On the other hand, if the batch piles are floating in a separated manner all over the furnace, the bubbler will move them back to the charging wall in a compact mass, and will permit an increase in production as much as 30 per cent. It is not possible to make a general statement on the increased production which is possible. Each furnace must be examined individually.

CONCLUSION

The decision as to whether to install electric boosting or bubbling or both depends on an examination of each individual furnace. If the problem is one of control of convection currents to keep the batch piles under control, or if improvement of homogeneity is required, or if only a small increase in production is required, the bubbling system is usually the best answer.

However, if a large increase in production is required, the bubbling installation will not be sufficient. In such cases, it is necessary to have an electric boosting system. With the electric boosting, the output of a furnace can be raised to a very high level, such as 3.75 short tons per square foot.

The bubbling and boosting systems work well together. In some furnaces, it is advisable to have both bubbling and boosting installations, taking advantage of the strong points of both systems.

RESEARCH DIGEST

(*Continued from page* 284)

fed onto the belt first, providing a base to prevent undue movement of the batch as it is conveyed to the furnaces.

Discharged from the belt, the batch and cullet flow down another pipe to the working storage hoppers at the furnace, where it is again discharged by a vibratory feeder to the batch chargers. The end port tank batch charging system also features a screw mixer, where water is introduced to give the batch a uniform moisture content of approximately 2 per cent. This small amount of water aids greatly in controlling the dusting of the batch, inside the furnace as well as at the doghouse.

It was assumed that regardless of the quality of materials handling equipment used, there would be times when it would need maintenance and endanger continued production, if out of service for too long a period. Also, no program of safeguarding the handling and mixing of raw materials is complete until their delivery to the furnaces has been assured. Several emergency batch handling systems are incorporated into the plant. A separate withdrawal pipe from each of the batch feeders allows the batch to be drained into cans should the conveyors become inoperative.

At the end-port furnace, the working storage is limited to about an hour and a half at top pulls. There is a provision for feeding batch from cans directly into the screw chargers. Each of the individual units of the charging system may be bypassed. Should the vibratory feeder or screw mixer fail, batch can be spouted to the screw chargers directly from the hopper, or may be fed to them by cans. Direct charging of batch by cans is relied upon for the unit-type melting furnaces. Spare screw feeders are available for immediate use in either furnace should they be necessary.

If the mixer should be out of service beyond the storage capacity of the batch bins and hoppers, a portable emergency mixer is on hand. The handling of batch materials from the scale to the mixer then becomes a wheelbarrow operation, with cans the media for transporting the mixed batch to the furnaces via lift trucks.

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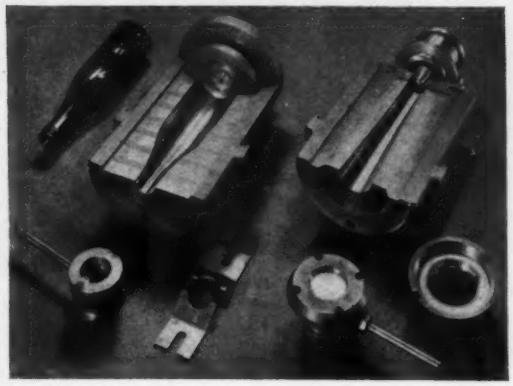

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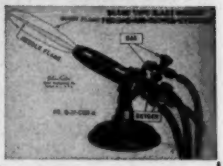

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INVENTIONS AND INVENTORS

(*Continued from page* 282)

This invention is applicable to glass feeder apparatus for feeding molten glass received from a glass furnace, and more specifically to a glass feeder provided with electrode elements for resistance heating the glass to a desired viscosity at the point of discharge.

In employing electrical energy through electrode elements to control this discharge temperature, the molten glass contained in the feeder spout is utilized as the resistance element in which the electrical energy is transformed into heat absorbed by the glass.

Supplementary to adding heat to the glass in the feed spout this invention utilizes means to stir the glass contained in the feed spout to mix the higher temperature core of glass near the center of the spout with the cooler outer portions to obtain more uniformity in the temperature and consistency throughout the body of glass contained in the spout. The present invention also provides a glass feeding spout for achieving desired temperature and viscosity conditioning of glass at point of discharge by electric resistance heating.

There was 1 claim and the following references cited.

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NEW BOOKS

(*Continued from page* 290)

The chapters include: (1) Glass (its nature, composition, mechanical strength); annealing; strain analysis; outgassing of glass; powdered glass; solder glass. (2) Ceramics. (3) Mica. (4) Carbon and Graphite. (5) Iron and Steels. (6) Copper and Copper Alloys. (7) Nickel and Nickel Alloys. (8) Precious Metals: Silver, Gold, and the Platinum Family. (9) Tungsten. (10) Molybdenum. (11) Tantalum and Niobium. (12) Join-

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—Vincent C. DeMaria

LETTERS TO THE EDITOR

This column is provided as a literary meeting place for readers who wish to share ideas, express opinions, and ask questions on glass, its manufacture and its applications. Your letters are most welcome.

Flat Glass — Too High?

Dear Sir:

In studying production figures for the flat glass industry, I have run across a curious discrepancy, and I wonder if you could explain it to me.

In the November 1959 (page 615) issue of your magazine, Table I of the article on "Flat & Structural Glass" shows the 1958 value of production & shipments at $189,019,000.

In the January 1960 (page 17) issue, "Flat Glass" reads ". . . should result in the flat glass industry increasing its 1960 production to $600 million, approximately 10 per cent above 1959." This would place 1959 production and/or shipments at about $545 million. Now clearly production couldn't have jumped from $189 million to $545 million between 1958 and 1959.

LAWRENCE ROSS
New York, N.Y.

This is probably because the data in the January article includes the value of finished flat glass products. This would include products that have been made into mirrors, safety glass, bent glass, picture windows, and spandrels. For example, in the article "The Glass Industry—1959", (page 69), February, 1960, you will note that the estimates for 1959 are considerably greater than the yearly production for 1958. These production figures are based on the glass produced only. The reason 1959 was so much greater than 1958 was due to the fact that the flat glass industry had a prolonged strike in 1958, which naturally cut down production for that year.

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